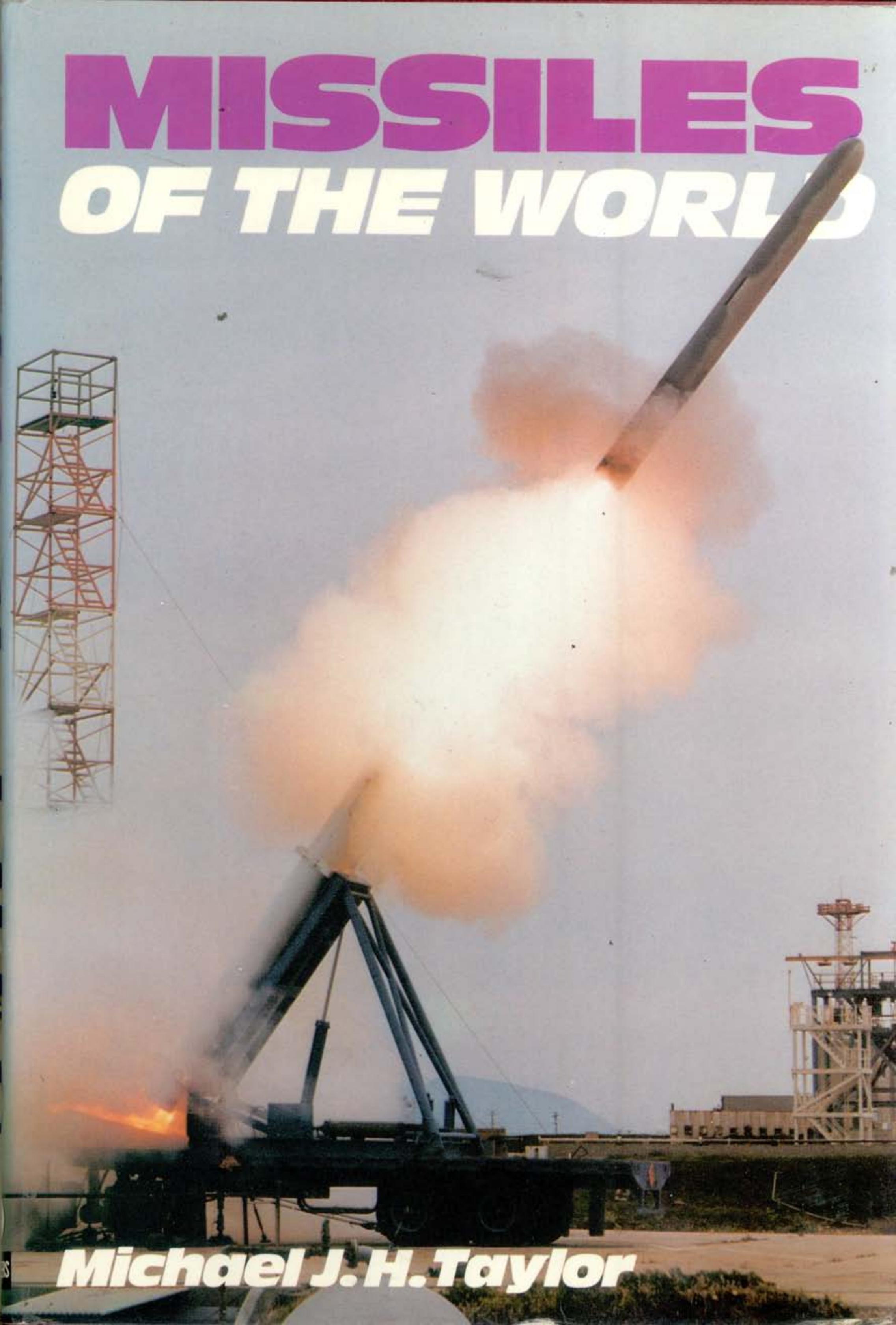
MISSILES

OF THE WORLD



Michael J. H. Taylor

$14.95

Missiles of the World
(Third Edition)
MICHAEL J. H. TAYLOR

Since its first publication in 1972, *Missiles of the World* has taken its place alongside its companion volumes *Military Aircraft of the World* and *Civil Aircraft of the World* as an established standard compact reference work. But many changes have taken place since then. Old, familiar names have disappeared from inventories, and the greatest advances in operational deployment have, as might be expected, come from the Soviet Union. The capability and throw weight of the latest Soviet strategic missiles is such that, according to the U.S. Department of Defense, the currently deployed U.S. Minutemen sites are extremely vulnerable to "first strike" destruction. Hence the SALT talks.

This third edition provides the hard facts behind the negotiations of the SALT II agreement. Many new photographs and considerable updating make this book an ideal reference for anyone interested in missile development and deployment.

Cover: *Ground launch of a Tomahawk cruise missile.*

APRIL 1984

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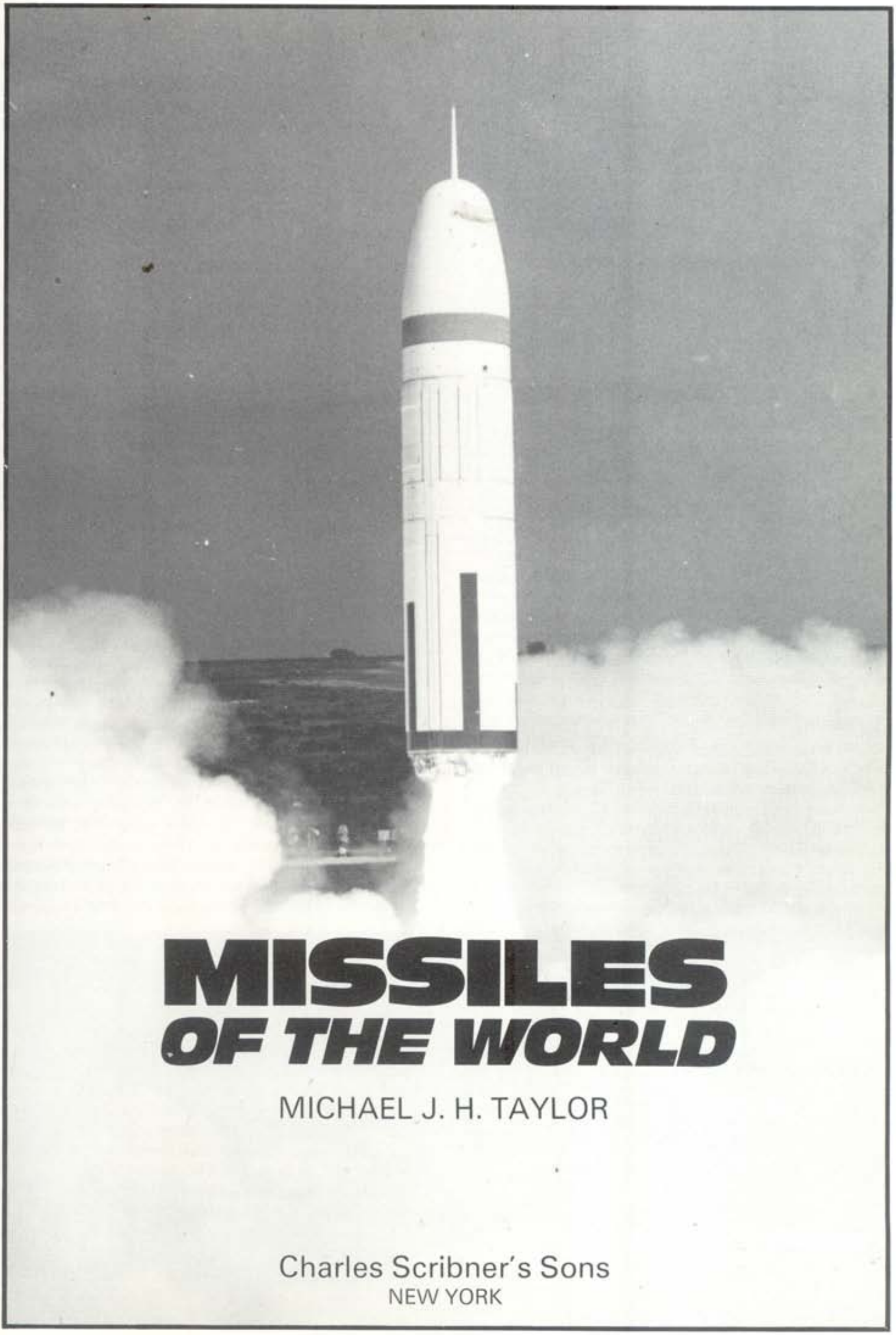
From the
library of
Daniel F. Elliott



MISSILES OF THE WORLD

MICHAEL J. H. TAYLOR

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Note

The quotation marks around a number of Soviet missiles, aircraft, naval units and arms indicate that the given name is a NATO reporting name. When they appear without quotation marks, they indicate the true Soviet class or type nomenclature which they have retained even if serving under another country's flag.

Addenda

A NATO reporting name has been issued for the AT-5 as 'Spandrel'. A man-portable tripod-mounted derivative of the AT-5 is the AT-4 'Spigot'. A 'fire-and-forget' anti-tank missile (AT-6), developed for the Mil Mi-24 'Hind' helicopter, is known to NATO as 'Spiral'. This is thought to home on targets illuminated by a laser designators and to have a range of up to 6.2 miles (10km).

It is now known that the Soviet designations of the SS-17, SS-18, SS-19 and SS-N-8 are the RS-16, RS-20, RS-18 and RSM-50 respectively.

Previous page: Trident 1 launch.

Foreword

The first edition of this book was launched into completely unexplored skies. Companion to *Helicopters of the World, Military Aircraft of the World* and *Civil Aircraft of the World, Missiles of the World* found a ready market. Engineers, members of the armed services, the press and broadcasting, government agencies, and thousands of others had clearly been waiting for a book that would give accurate, up-do-date information on every guided missile known to be in service or under development throughout the world. When the Strategic Arms Limitation Talks between America and Russia brought the first agreement (SALT I) to reduce the crippling cost of an arms race with weapons of ultimate destruction, this focused attention on the subject of the book.

Much more has been learned about Soviet missiles since 1972 and, indeed, since the second edition of the book appeared in 1978. The precise number of intercontinental ballistic missiles (ICBMs) and submarine-launched ballistic missiles (SLBMs) deployed by the two super powers became common knowledge after the signature of the SALT I agreement. Information on new developments has been made available more freely, now that continuous surveillance by satellite is accepted as a guarantee of good faith by both sides. As a result, it has been possible to pack a truly astonishing amount of new material into this third edition of *Missiles of the World*, requiring a more extensive revision than is customary for even its 'Aircraft' companions.

All information is presented in a way that can be understood easily by non-technical readers. This task has been assisted by correspondents, manufacturers and official organisations in more than a dozen countries. To them all is expressed our sincere gratitude, for these terrifying weapons can serve their purpose only if their potential is fully understood. Our world will remain safe from major war only so long as the leaders of both East and West are left in no doubt of what would be the consequences of any act of major aggression.

Foreword to the Third Edition

Many changes have taken place since the second edition went to press. Old and familiar names have disappeared from inventories — Falcon AIM-26, Frog-1 and 2, Hound Dog, Nike Ajax, 'Saddler', 'Sark', 'Sasin', 'Scrubber', 'Scud-A', Sea Killer Mk 1, Sergeant and Thunderbird — while the greatest advances in operational deployment of new missiles has, as might be expected, come from the Soviet Union. Such is the capability and throw weight of the latest Soviet strategic missiles that, according to the US Department of Defense, the currently deployed US Minuteman sites are extremely vulnerable to 'first strike' destruction. Meanwhile a SALT II agreement, which would be in force until the end of 1985, has still to be ratified.

M.J.H.T.

AAM-1

Japan

Air-to-air missile. In service.

Prime contractor: Mitsubishi Heavy Industries Ltd
Guidance and Control: Infra-red homing guidance system
Warhead: High-explosive

Development and Service

Mitsubishi Heavy Industries developed this air-to-air missile specifically to replace the Sidewinder on F-86F and F-104J interceptors of the Japan Air Self-Defence Force (JASDF). Deliveries began in 1970 and the planned production of 330 missiles was completed by late 1971. No details of the AAM-1 have been released for publication, except that it is a pursuit-course weapon, limited to attack from the rear of the target.

AAM-2

Japan

Air-to-air missile.

Development and Service

The AAM-2 was being developed by Mitsubishi as a replacement for the AAM-1. It has been reported that the project has now been abandoned.

Acrid (AA-6)

USSR

Air-to-air missile. In service.

Airframe: Cylindrical body with ogival nose cone. Large cruciform wings, indexed in line with cruciform foreplanes
Guidance and Control: Alternative infra-red and semi-active radar homing guidance systems
Warhead: High-explosive
Length: Radar-homing approx 20ft 0in (6.10m)
Range: at least 23 miles (37km)

Development and Service

Largest Soviet air-to-air missile yet identified in service, 'Acrid' is carried by the Mach 3 MiG-25 interceptor ('Foxbat-A'). Deployment on this aircraft can comprise one IR and one radar guided missile under each wing. The 'Foxbat-A' wingtip fairings are believed to house continuous wave target illuminating equipment, used in association with radar-homing 'Acrid' missiles.

Below: 'Acrid' missiles under the wings of MiG-25 'Foxbat' interceptors.

Advanced Terrier (RIM-2F)

USA

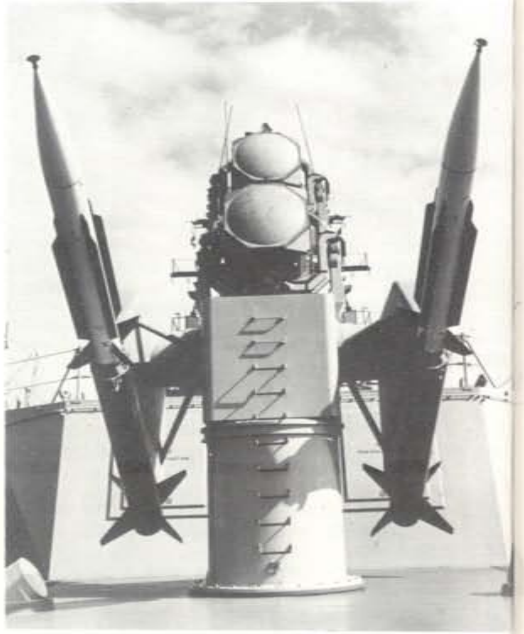
Ship-based surface-to-air missile. In service.

Prime contractor: General Dynamics Corporation
Powered by: Allegany Ballistics Laboratory tandem two-stage solid-propellant rocket motors
Airframe: Tandem two-stage design. Cylindrical missile body, with long ogival nose; cruciform long-chord wings of constant narrow span with cruciform tail control surfaces immediately to their rear. Cylindrical tandem booster of larger diameter, with cruciform cropped-delta fins at rear, indexed in line with missile surfaces
Guidance and Control: General Dynamics (Pomona) beam-riding guidance with semi-active terminal homing. Control by movable tail surfaces
Warhead: Naval Ordnance Laboratory high-explosive warhead, with proximity fuse
Length: 27ft 0in (8.23m)
Body diameter: Missile 1ft 1.5in (0.34m) Booster 1ft 4in (0.406m)
Wing span: 1ft 8in (0.51m)
Launch weight: 3,000lb (1,360kg)
Max speed: Mach 2.5
Max range: approx 22 miles (35km)
Effective ceiling: 12.4 miles (20km)

Development and Service

The original Terrier missile (RIM-2A, formerly SAM-N-7) was evolved from an experimental vehicle named Lark and became operational on ships of the US Navy in 1956. It was followed seven years later by Advanced Terrier, with new beam-riding guidance which offered greatly increased effectiveness against low-flying aircraft and multiple targets, and also gave the missile a surface-to-surface capability. Externally, the Advanced weapon differs from Terrier mainly in having strake-like wings instead of the former small cropped-delta surfaces.

Advanced Terrier continues to arm several US attack carriers and cruisers as well as three Italian cruisers, but has been widely superseded by Standard Missile.



Aegis

USA

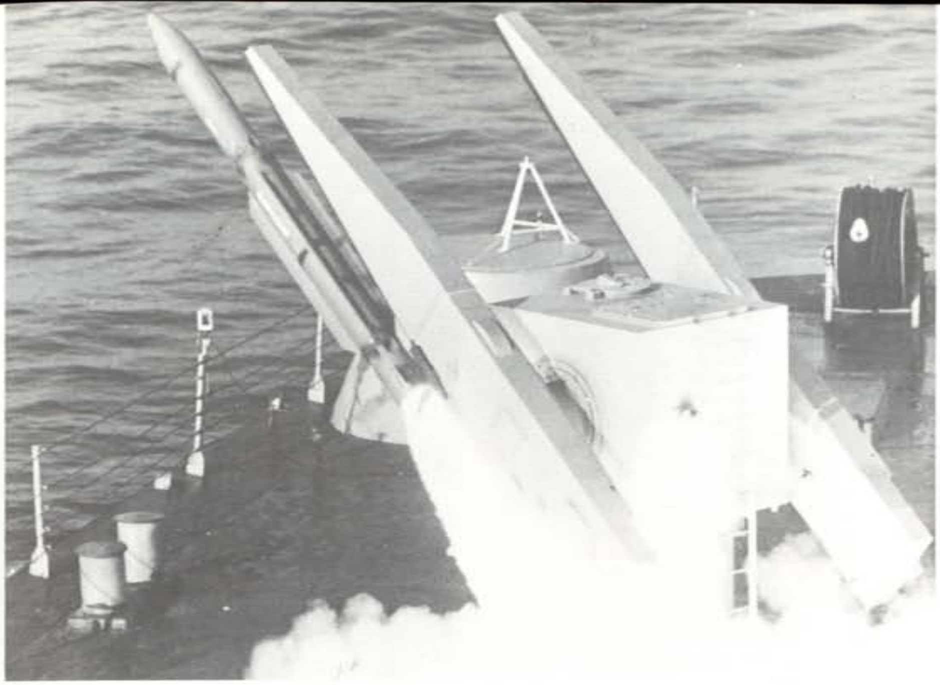
Surface-to-air ship-based weapon system. Under development.

Prime contractor: Radio Corporation of America

Development and Service

Aegis was known originally as the Advanced Surface Missile System (ASMS) and is expected to be the US Navy's primary defensive missile system in the 1980s. It is designed primarily for defence against anti-ship missiles, and is planned as an area-defence system, able to protect an entire task force. Initial deployment is expected to be on board a new class of strike cruisers and guided missile destroyers. System features include the AN/SPY-1 multi-function phased array radar which is capable of surveillance and the simultaneous detection and tracking of multiple targets, Mk 26 dual-purpose launcher able to launch Asroc and Harpoon missiles as well as the SM-2 missiles for Aegis, the AN/UYK-7 digital computer, Mk 99 fire control system to illuminate and if necessary track the target, Mk 12 weapon direction system, Mk 130 command and control system, and Mk 545 operational readiness test system (ORTS).

Initial planning for Aegis started in 1964. An engineering development contract was awarded to RCA in December 1969, and land-based testing was completed successfully in 1973. The system was installed on the test ship USS *Norton Sound*, which began sea trials in early 1974, and successfully demonstrated its operational capabilities. Thirty-three Aegis firings had been made by March 1977, including the first with an SM-2 missile in December 1976. Evaluation and demonstration of Aegis continued in 1979. The first new ship to be Aegis-armed is expected to be the guided missile destroyer DDG-47 to be commissioned in 1982.



Albatros

Italy

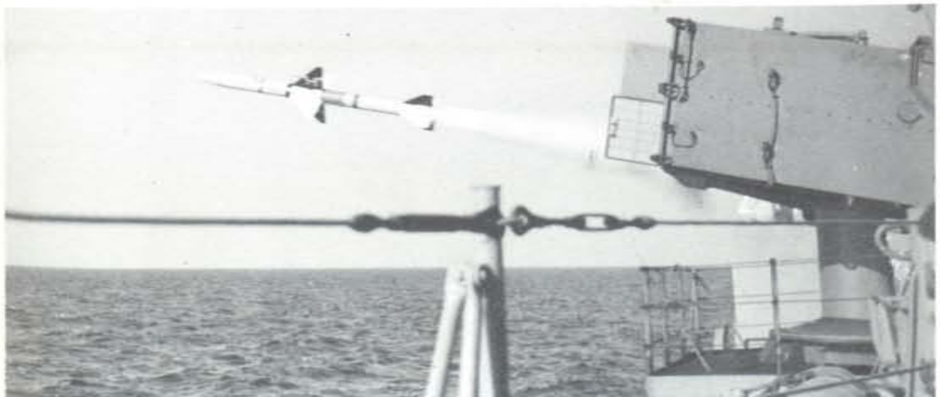
Surface-to-air missile system. In production and service.

Prime contractor: Selenia Industrie Elettroniche Associate SpA
Wing span of missile: 2ft 7.5in (0.80m)

Development and Service

The Albatros weapon system is intended to provide naval craft with all-weather point defence against attack by aircraft and missiles, down to very low altitudes. It consists of either a Ferranti WSA-400 digital gun fire control system or Elsag NA-10 gun fire control system, Selenia Orion RTN 10X tracking pulse radar, a missile launching system and anti-aircraft guns, and Aspide missiles (with shorter span wings and tail surfaces than the air-to-air version). Only a single operator is required for the Albatros system, to carry out radar control functions, missile launch and gun fire control. Defensive cover is provided from the maximum range of the missiles down to the minimum effective range of the guns (about 1,000ft, 300m).

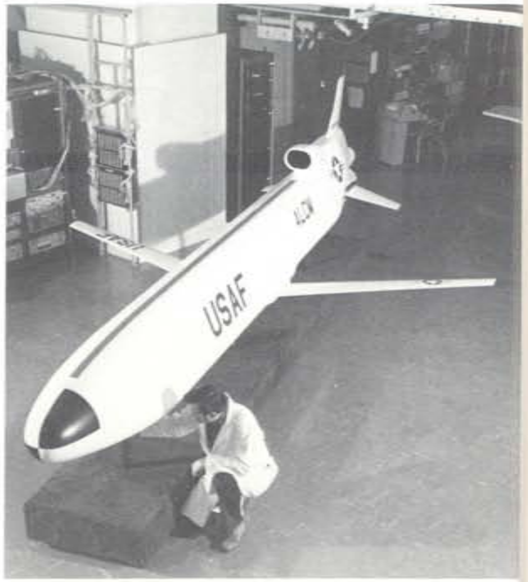
Selenia received an official contract to begin development of the Albatros system in early 1968. Successful firing trials against target drones in Sardinia were followed by operational evaluation on board a ship of the Italian Navy in 1973. However the original Albatros system using RIM-7H Sparrow missiles was subsequently abandoned. The current system with Aspide missiles is known as Albatros Mk 2. A lightweight Albatros system has also been developed for small naval vessels, with four-round instead of eight-round launchers. Albatros is now in production for the Italian Navy and a number of foreign navies, including those of Greece, Peru and Venezuela.



ALCM (AGM-86B)

USA

Air-launched cruise missile. Under development.



Prime contractor: Boeing Aerospace Company
Powered by: Williams Research Corporation F107-WR-100 turbofan engine in the 600lb (272kg) thrust class
Guidance and Control: Inertial guidance system, plus terrain contour matching (TERCOM)
Warhead: Nuclear
Length: 20ft 9in (6.32m)
Body diameter: 2ft 1.5in (0.65m)
Wing span: 12ft 0in (3.66m)
Launch weight: 2,825lb (1,282kg)
Range: over 1,500 miles (2,400km)

Development and Service

The original short-range AGM-86A version of the ALCM was evolved from SCAD (Subsonic Cruise Armed Decoy), a projected replacement for Quail which was cancelled in 1973. It retained the same basic airframe, with folding wings and tail so that it could be carried on the SRAM rotary launcher. When carried externally, it could be fitted with an underbelly fuel tank to increase its range. However, development is currently centred on a larger version of the ALCM, designated AGM-86B, which has a much greater range. The B-52 will still carry 20 missiles. It is reported that 95% of the components for the AGM-86B are similar to those of AGM-86A, including the engine, guidance and navigation systems.

Before launch, a predetermined target is programmed into each missile. During the terrain contour matching mode of flight, a computer in the missile keeps it on course by matching the geography seen by its sensors with a pre-programmed map storage device. Any error between where the missile is and where the map says it should be is then computed and the missile steers back on course and towards the next predetermined map area. Many ALCMs attacking at once are intended to confuse and spread out the effectiveness of defending forces, and so improve the chances of manned bombers to penetrate major targets.

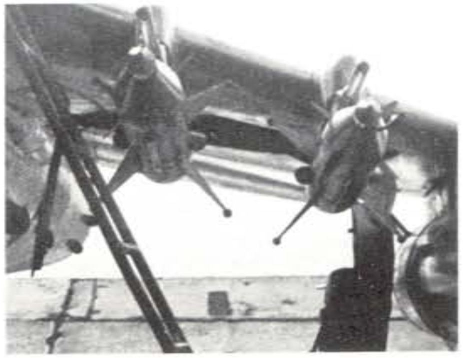
Flight testing of the initial batch of AGM-86A ALCM development missiles began on 5 March 1976. During 1979 10 AGM-86Bs were flight tested against the air-launched version of the Tomahawk, and a production decision is expected in 1980, with initial deployment in the early 1980s. The ALCM is also being considered for deployment in Europe in non-nuclear, decoy and reconnaissance roles.

Below: AGM-86A ALCM launched from a B-52 on its first powered flight, 5 March 1976

Alkali (AA-1)

USSR

Air-to-air missile. In service.



Powered by: Solid-propellant rocket motor
Airframe: Basically-cylindrical body, with large rear-mounted cruciform wings of delta shape, indexed in line with small cruciform foreplanes. Control surfaces in wing trailing-edges
Guidance and Control: Semi-active radar homing system. Control via wing trailing-edge surfaces
Length: 6ft 2in (1.88m)
Body diameter: 7in (0.178m)
Wing span: 1ft 10.75in (0.58m)
Launch weight: approx 200lb (90kg)
Range: 3.7-5 miles (6-8km)

Development and Service

'Alkali' continues to be carried by all-weather interceptor versions of the MiG-19, in service with some of Russia's allies and friends. It was the first-generation missile armament of this fighter and of the Sukhoi Su-9.

AMRAAM

USA

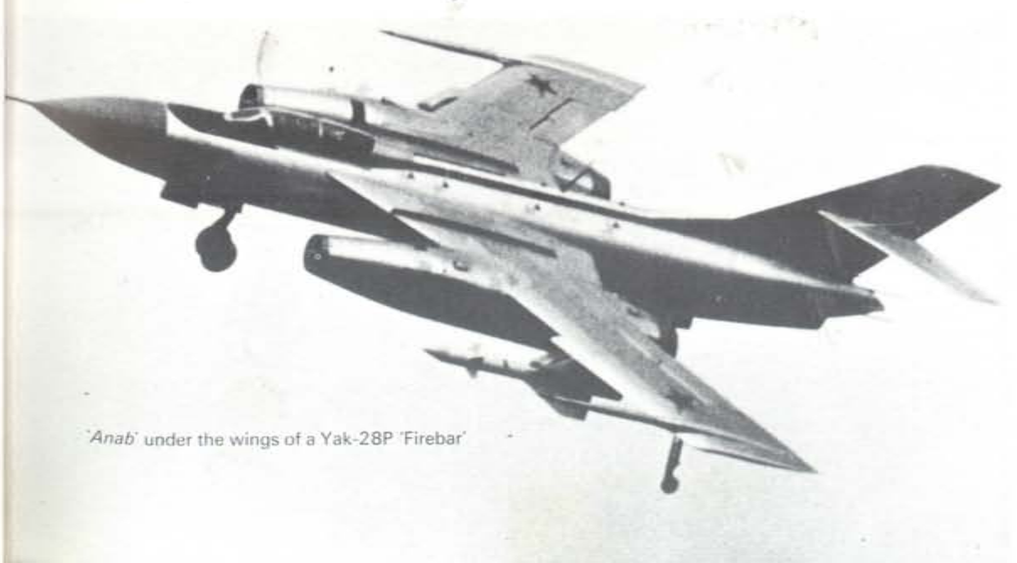
Advanced medium-range air-to-air missile. At initial design stage.

Development and Service

The AMRAAM has been initiated as a US Tri-Service programme to assess the possible air-to-air threat into the 21st century and begin definition of a missile capable of dealing with it. Five US manufacturers are engaged in separate projects. The missile is to be an all-weather weapon with snap-down capability, have resistance to electronic countermeasures to a degree equal if not better than present monopulse techniques, have all aspect launch/tracking ability and good range. Launch weight is to be kept below 350lb (160kg). When operational, the missile will arm Grumman F-14 Tomcat, McDonnell Douglas F-15 Eagle, General Dynamics F-16 and McDonnell Douglas F-18 Hornet fighters.

Anab (AA-3)

USSR



'Anab' under the wings of a Yak-28P 'Firebar'

Air-to-air missile. In service.

Airframe: Cylindrical body, fitted with large cruciform tail-fins and small cruciform foreplanes
Guidance and Control: Alternative infra-red and semi-active radar homing guidance systems. Control by movable foreplanes
Warhead: High-explosive
Length: IR version 13ft 5in (4.1m)
Radar homing version 13ft 1in (4.0m)
Body diameter: 11in (0.28m)
Wing span: 4ft 3in (1.30m)
Range: over 10 miles (16km)

Development and Service
Like the USAF, the Soviet Air Force learned by experience the value of carrying both infra-red homing and radar homing missiles on its interceptors, for use under varying weather conditions and in different tactical situations. The Sukhoi Su-11 'Fishpot-C' and Yakovlev Yak-28P 'Firebar' all-weather fighters of the Protivo-Vozdushniya Oborona Strany (National Anti-Air Defence force) are thus armed usually with one 'Anab' of each type on underwing racks, although the Yak-28P is being phased out of service. 'Anabs' are also carried by the single-seat twin-jet Sukhoi Su-15 'Flagon'.

Apex (AA-7)

USSR

Air-to-air missile. In production and service.

Powered by: Solid-propellant rocket motor
Airframe: Cylindrical body with mid-positioned cruciform delta wings, indexed in line with cruciform tail fins and foreplanes
Guidance and Control: Alternative infra-red and semi-active radar homing guidance systems
Length: 14ft 1.25in (4.30m)
Body diameter: 9.5in (0.24m)
Wing span: 3ft 5.5in (1.05m)
Launch weight: 705lb (320kg)
Range: 17 miles (27km)

Development and Service
This new missile is one of the weapons carried by MiG-23 'Flogger' interceptors of the Soviet Air Force and has been named as an alternative missile for the MiG-25 'Foxbat'.

Aphid (AA-8)

USSR

Air-to-air missile. In production and service.

Powered by: Solid-propellant rocket motor
Airframe: Cylindrical body fitted with large rear-mounted cruciform wings of cropped delta shape, indexed in line with small cruciform foreplanes
Guidance and Control: Infra-red homing guidance. Control probably by foreplanes
Warhead: 13.2lb (6kg) weight
Length: 6ft 6.75in (2.00m)
Body diameter: 5in (0.13m)
Launch weight: 121lb (55kg)
Range: 3.5-5 miles (5.5-8km)

Development and Service
Nothing more is known of this 'dogfight' missile, which can be carried by MiG-23 'Flogger' interceptors.

Argentine air-to-surface missile

Argentina

Prime contractor: Armed Forces Scientific and Technical Research Centre
Guidance: Radio command
Warhead: 88lb (40kg) weight
Launch weight: 254lb (115kg)
Max range: 4.35 miles (7km)

Development and Service
The Centre has designed and built an air-to-surface missile for possible future deployment on fixed- and rotary-wing aircraft of the Argentine Navy. The eight research and development missiles are being followed by a pre-production batch of 50 missiles.

Argentine anti-tank missile

Argentina

An Argentinian anti-tank missile, in the same class as Cobra, is thought to have become operational in 1979.

AS-8

USSR

Air-to-surface missile. In service.

Range: 5 miles (8km)

Development and Service
The AS-8 is a new Soviet helicopter-launched 'fire-and-forget' missile, developed for attacking armoured vehicles and suppression of air defence sites. It has been supplied to Mil Mi-24 'Hind-A and D' units, and it will also arm the light attack helicopter currently under development in the Soviet Union.

AS.11 (AGM-22A)

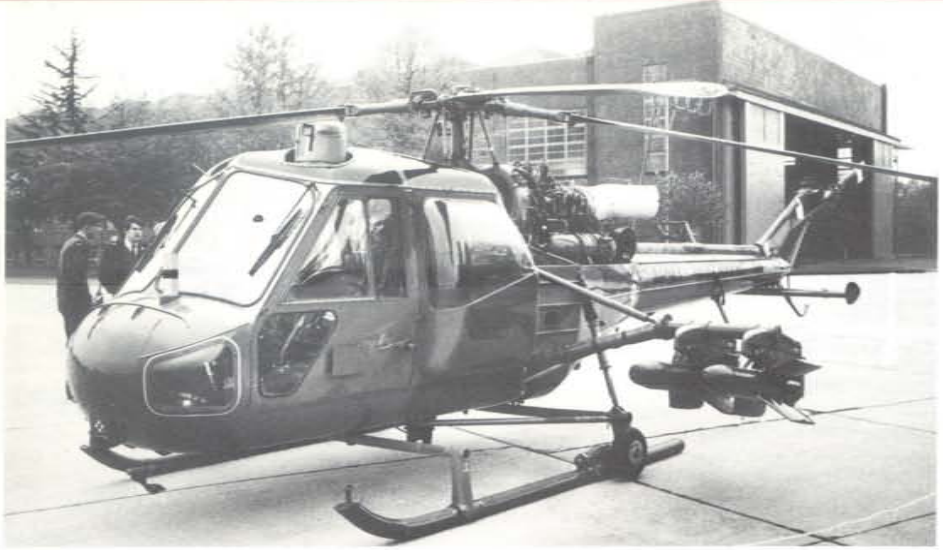
France

Air-to-surface tactical missile. In production and service.

Prime contractor: Aérospatiale, Division Engins Tactiques
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical body, with cruciform sweptback wings and rounded nose
Guidance and Control: Wire guidance. Control by varying sustainer thrust through two side-nozzles
Warhead: High-explosive, high-fragmentation anti-personnel or armour-piercing, of several types
Length: 3ft 11in (1.20m)
Body diameter: 6.5in (0.16m)
Wing span: 1ft 7.5in (0.50m)
Launch weight: 66lb (29.9kg)
Average cruising speed: 360mph (580km/h)
Range limits: 1,150-9,840ft (350-3,000m)

Development and Service
This is the air-to-surface version of the SS.11 tactical missile, to which it is generally similar. When carried by helicopters, it is normally controlled by means of a specially-developed stabilised and magnifying sight. After launch, the missile is aligned with the target by the operator, using a control stick. Tracer flares at the rear of the missile help to give visual reference. The AS.11 B.1 version has been in production since 1962 and is in service with the French armed forces and those of 27 other countries (incl SS.11), including the UK and USA, by which it is designated AGM-22A. Production of AS/SS.11 totalled 168,340 by January 1979, including Harpons. Licence manufacture has been undertaken in West Germany and India.

Below: AS.11 fired from an Alouette III helicopter.



Above: AS.11s on a British Army Scout helicopter.

AS.12

France

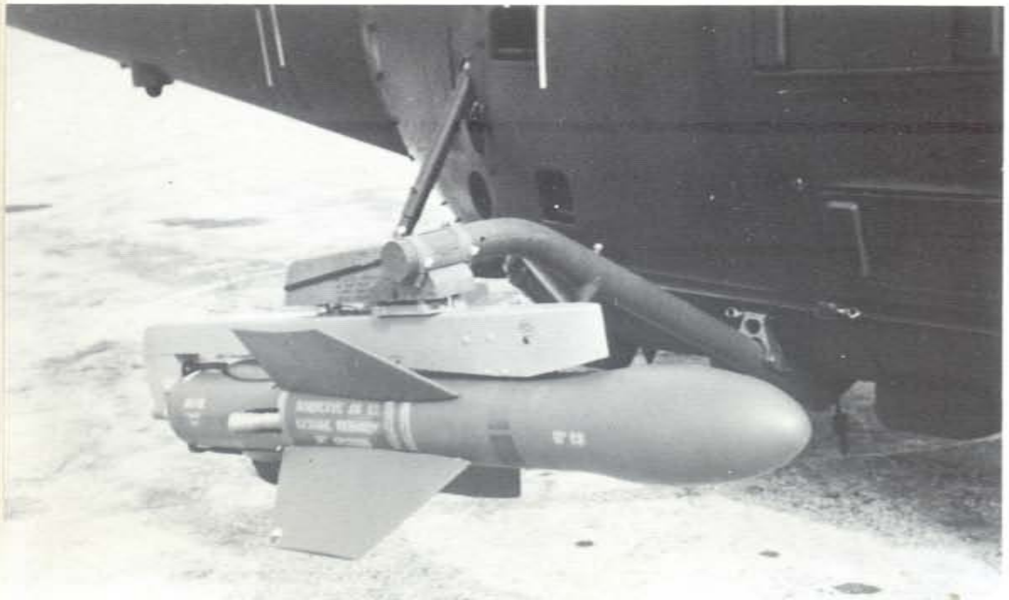
Air-to-surface missile. In production and service.

Prime contractor: Nord-Aviation/Aérospatiale, Division Engins Tactiques
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical body, with cruciform wings and bulged ogival nose
Guidance and Control: Wire-guidance, under manual control. The missile is spin-stabilised and steered by varying the sustainer thrust through two side-nozzles

Warhead: High-explosive, weighing 62.6lb (28.4kg)
Length: 6ft 1.9in (1.87m)
Body diameter: 7in (0.18m)
Wing span: 2ft 1.5in (0.65m)
Launch weight: 170lb (77kg)
Speed at impact: 210mph (335km/h) when launched at 230mph (370km/h)
Max range: 19,685ft (6,000m)

Below: AS.12.

Top right: AS.12s on an Alouette III helicopter.

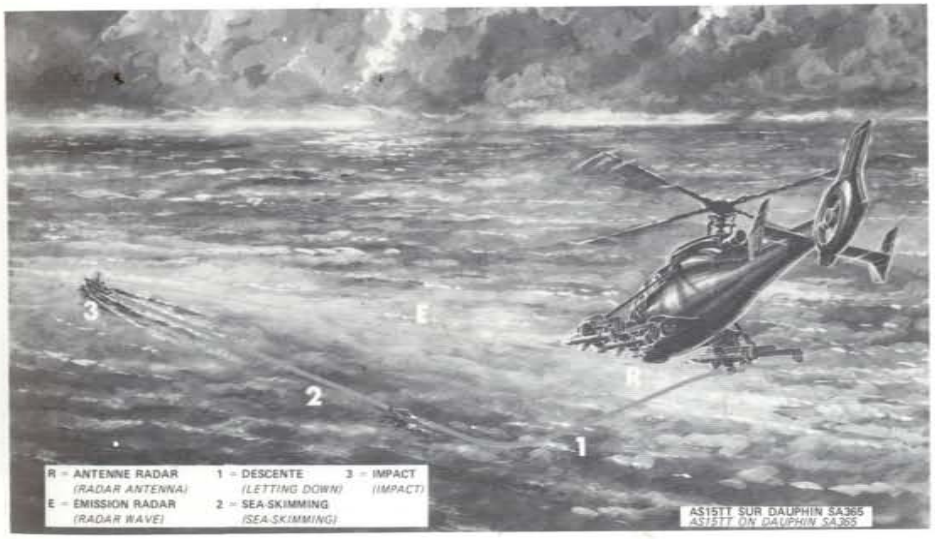


Development and Service

By scaling up the basic SS.11 and AS.11 to produce the SS.12 and AS.12, Nord-Aviation was able to fit a much larger warhead and so create a missile that would be effective against fortified positions as well as tanks, ships and other vehicles. The armour-piercing version will penetrate more than 1.5in (40mm) of steel armour and explode on the other side. Alternatives include an anti-tank shaped charge and a pre-fragmented anti-personnel type. All AS.12s are steered manually. They are carried by Alizé, Atlantic, Neptune and Nimrod anti-submarine aircraft and, in conjunction with an optical stabilised sight, by Alouette, Lynx and Wessex helicopters of the French Navy, Royal Navy and other naval air arms. Orders totalled 8,287 missiles (and SS.12s) by January 1979.

AS.15 and AS.15TT

France


3
E
R
2
1
R = ANTENNE RADAR (RADAR ANTENNA)
E = EMISSION RADAR (RADAR WAVE)
1 = DESCENTE (LETTING DOWN)
2 = SEA-SKIMMING (SEA-SKIMMING)
3 = IMPACT (IMPACT)
AS15TT SUR DAUPHIN SA365
AS15TT ON DAUPHIN SA365

Above: Artist's impression of an AS.15TT attack from an SA365 Dauphin II helicopter.

Air-to-surface missile. Under development.

Data: AS.15TT
Prime contractor: Aérospatiale, Division Engins Tactiques
Airframe: Cylindrical body with ogival nose. Cruciform mid-positioned wings, indexed in line with tail fins
Guidance and Control: Radar tracking. Radio altimeter. Control via tail fins

Warhead: As for AS.12
Length: 7ft 1in (2.16m)
Body diameter: 7.25in (0.185m)
Wing span: 1ft 9in (0.53m)
Launch weight: 211lb (96kg)
Cruising speed: 626mph (1,008km/h)
Range: over 9.3 miles (15km)

Development and Service

The AS.15 fair weather missile and the all-weather AS.15TT (Tous Temps) are being projected as possible replacements for the AS.12. It is planned to use them from helicopters and maritime patrol aircraft, as well as from shore bases or surface ships, against vessels of all tonnages. The former uses radio command guidance with optical/infra-red tracking, while a radar tracking method is used with the AS.15TT in conjunction with the Agrion 15 radar in the launch aircraft for automatic tracking of the target and differential target to missile range and bearing measurement. The Agrion 15 performs well against small vessels in all weather conditions and in the presence of ECM. In operation, the target is detected and identified. The radar is then switched to automatic tracking and the AS.15TT is launched. The missile is thereafter guided automatically and descends to a sea-skimming altitude. Impact cruising altitude is approximately 16-20ft (5-6m). Hit probability is claimed to be near 100%, even at maximum range. The missile can also be launched from very low flying aircraft.

AS.20

France

Development and Service

The AS.20 air-to-surface missile is being withdrawn from service. (See Second Edition of *Missiles of the World*.)

Below: AS.20 on an F-104G Starfighter of Marinefliegergeschwader 1, German Navy.

AS.30

France

Tactical air-to-surface missile. In service.

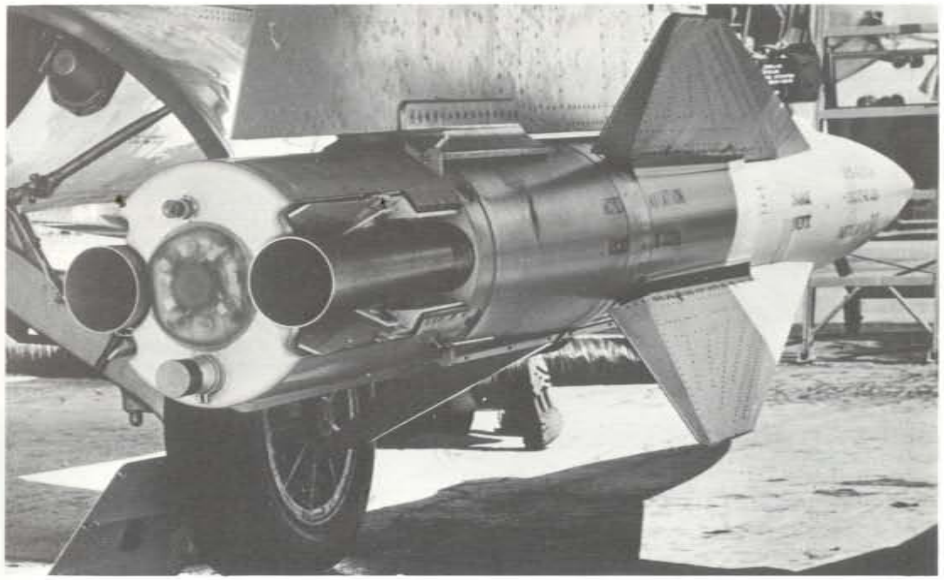
Prime contractor: Nord-Aviation/Aérospatiale, Division Engins Tactiques
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical body with pointed ogival nose. Canted cruciform sweptback wings, indexed in line with cruciform flip-out tail-fins
Guidance and Control: Radio command, with optional TCA automatic guidance
Warhead: High-explosive, weighing 510lb (230kg), with delay or non-delay fuse, or semi armour-piercing
Length: 12ft 7in (3.84m) or 12ft 9in (3.89m) depending on warhead
Body diameter: 1ft 1.5in (0.34m)
Wing span: 3ft 3.5in (1.00m)
Launch weight: 1,146lb (520kg)
Speed at impact: 1,005-1,120mph (1,620-1,800km/h)
Average range: 6.8-7.5 miles (11-12km)

Development and Service

Scaled up from the AS.20, with added flip-out tail-fins, this formidable missile is used by the French Air Force and Navy, the RAF, and the Air Forces of Germany, South Africa and Switzerland. It was designed to guarantee impact within a 33ft (10m) circle drawn around the aiming point when launched more than 6 miles (10km) from the target, without any need for the launch aircraft to approach within 1.8 miles (3km) of the target. This specification was exceeded by the production missiles, of which 3,855 have been delivered. Production has now ended. They can be launched at any speed above Mach 0.45, with no upper limit.

Many of the AS.30s in service with the French Air Force have been adapted to utilise TCA (Télécommande Automatique) guidance, which frees the operator of having to 'acquire' the missile after launch and align it manually on the target by means of a small joystick control. Instead, the operator simply keeps an optical sight aligned on target. After launch, infra-red radiation from a flare on the missile is picked up by a goniometer, the reference axis of which is parallel to the axis of the optical sight. The goniometer passes to a computer information on any deviation of the missile from this axis; corrections are then passed to the missile automatically by command signals, to bring it parallel to the line of sight and keep it there. Tests have shown that TCA can keep a missile within less than 3ft 3.5in (1.0m) of the direct line to the target.

Aérospatiale and Thomson-CSF (for homing head) have developed jointly a laser-guided version of the AS.30 as armament for Jaguar aircraft, which is described separately.



AS.30 Laser

France

Tactical air-to-surface missile. Under development.

Prime contractor: Aérospatiale, Division Engins Tactiques
Airframe: Similar to AS.30 but with hemispherical glass nose. Wings canted for spin stabilisation
Guidance and Control: Two-stage guidance; gyro reference followed by laser terminal homing
Warhead: High-explosive, weighing 529lb (240kg)
Length: 12ft 0in (3.65m)
Body diameter: 1ft 1.5in (0.342m)
Wing span: 3ft 3.5in (1.00m)
Launch weight: 1,146lb (520kg)
Range: 6.2-7.5 miles (10-12km)

Development and Service

The AS.30 Laser has been developed to supersede the AS.30 (qv). It is similar to the earlier missile in

configuration and weight, but has laser terminal homing using the Thomson-CSF Ariel homing head. The Thomson-CSF Atlis target illuminating pod is used in association with the missile, and was first tested under a Jaguar A in 1977. Initial test firings of AS.30 Laser missiles were expected to begin in the latter part of 1978. First production deliveries are expected in late 1981.

Above: AS.30 Laser under the wing of a SEPECAT Jaguar.

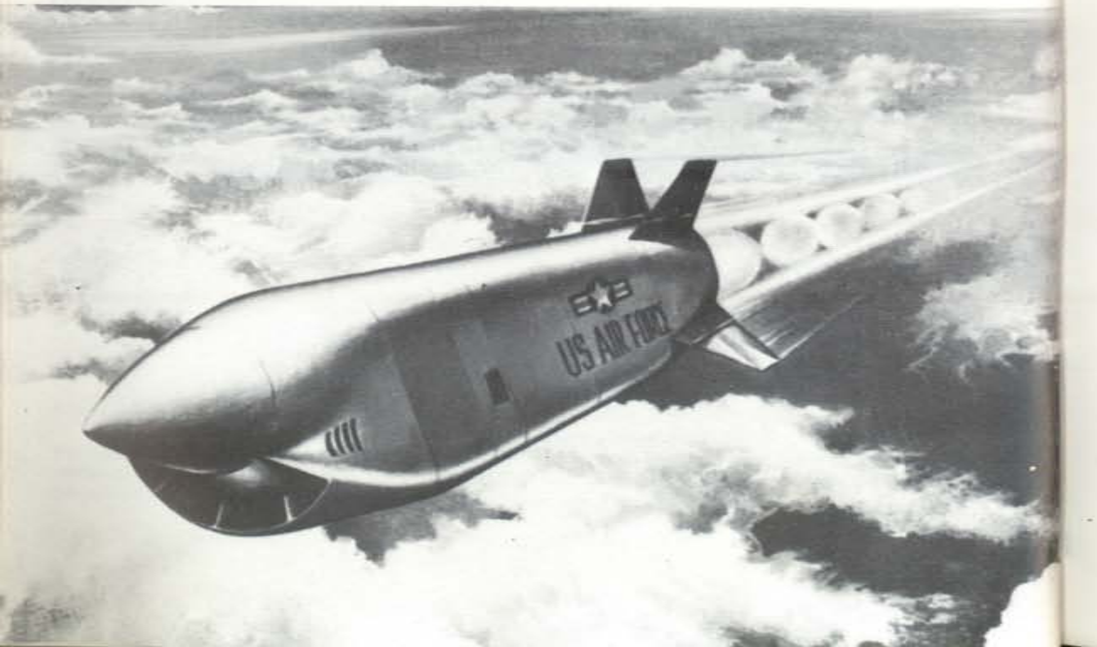
ASALM

USA

Advanced strategic air-launched missile. At design stage.

Contractors: McDonnell Douglas and Martin Marietta
Powered by: Integral rocket-ramjet, for which Marquardt and CSD have development contracts

Development and Service
Projected as a replacement for SRAM and complement the ALCM subsonic cruise missile in the 1980s, ASALM (advanced strategic air-launched missile) will be the first USAF weapon to utilise integral rocket-ramjet propulsion. In operation, a solid-propellant rocket booster, packaged in the missile's combustion chamber, will power ASALM to a high supersonic speed. Air inlets will then open to allow outside air to be 'rammed' into the combustion chamber, where it will be mixed with liquid fuel and ignited to provide cruise thrust. Design and ground testing of such propulsion systems are being carried out by the Marquardt Company and Chemical Systems Division of UTC. Contracts for ASALM concept studies and advanced technology development have been awarded to McDonnell Douglas and Martin Marietta. The missile has to be compatible with the SRAM rotary launcher, and be capable of both high-level and low-level penetration of enemy airspace at a somewhat higher speed than SRAM. ASALM will be capable of both air-to-air and air-to-ground missions.



Ash (AA-5)

USSR

Air-to-air missile. In service.

Airframe: Basically cylindrical body. Large cruciform delta wings indexed in line with cruciform tail surfaces
Guidance and Control: Alternative infra-red and semi-active radar homing guidance systems
Warhead: High-explosive
Length: IR version 18ft 0in (5.5m)
Radar-homing version 17ft 0in (5.2m)
Range: 18.5 miles (30km)

Development and Service
'Ash' is normally carried as a 'mix' of infra-red and radar homing versions by all-weather fighters of the Soviet Air Force. The big Tupolev Tu-28P twin-jet interceptor has underwing attachments for two missiles of each type. Several thousand 'Ash' missiles were built.

ASM-1

Japan

Air-to-surface missile. In production.

Prime contractor: Mitsubishi Heavy Industries Ltd
Guidance and Control: Inertial system for mid-course guidance; active radar seeker for terminal guidance
Warhead: 440lb (200kg) weight
Length: 13ft 1.5in (4.00m)
Body diameter: 1ft 1.75in (0.35m)
Wing span: 3ft 11.25in (1.20m)
Launch weight: 1,345lb (610kg)
Cruising speed: Mach 0.9
Range: 50-56 miles (80-90km)

Development and Service
Mitsubishi Heavy Industries was selected in November 1973 as prime contractor for the development of a new air-to-surface rocket-powered anti-shipping missile to be carried by the Mitsubishi F1 aircraft. This missile is also capable of being ground or ship launched with the aid of a rocket booster. It has been designed to fly to its target at low altitude, using a TRT/Japan Radio ANV-7 radio altimeter for mid-course guidance.

Twenty-five prototype ASM-1s have been delivered, and two were launched from a Mitsubishi T-2 in December 1977 at a height of 2,500ft (760m). Production ASM-1s are expected to be delivered to the JASDF in 1979.

ASMP

France

Air-to-surface missile. Under development.

Prime contractor: Aérospatiale, Division Engins Tactiques
Powered by: Liquid-propellant ramjet
Guidance and Control: Inertial guidance. Control via tail fins and rudders
Warhead: Nuclear, approx 100-150 kiloton yield
Range: approx up to 62 miles (100km)

Development and Service
Following cancellation of development of the original ASMP missile, a new design and development contract for the Air-Sol Moyenne Portée was awarded to Aérospatiale in March 1978, announced officially on 6 April of that year. It will be a tactical missile, with possibly limited strategic capability, and will carry the French Air Force's latest tactical nuclear warhead. It is expected to enter service by 1985, although original estimates were for 1983, to arm the Dassault Mirage 2000.

Aspide

Italy

Air-to-air and surface-to-air missile. In production.

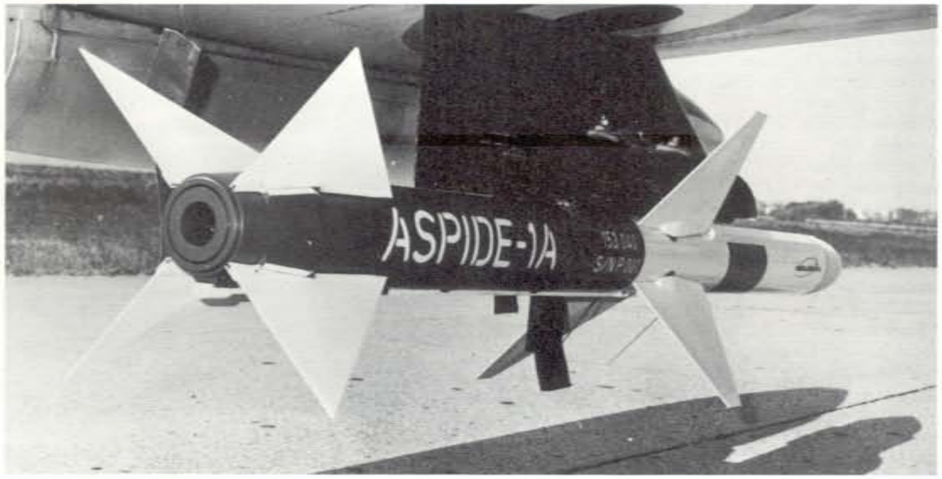
Prime contractor: Selenia Industrie Elettroniche Associate, SpA
Powered by: SNIA Viscosa solid-propellant rocket motor
Airframe: Cylindrical body with pointed ogival nose. Mid-set pivoted cruciform wings indexed in line with cruciform tail surfaces
Guidance and Control: Semi-active radar homing by Selenia. Monopulse receiving system designed for effectiveness at very low altitude and against multiple targets
Warhead: Fragmentation type; estimated weight 73lb (33kg)
Length: 12ft 1.5in (3.70m)
Body diameter: 8in (0.203m)
Wing span: 3ft 3.25in (1.00m)
Launch weight: 485lb (220kg)
Cruising speed: Mach 4
Range: 31-62 miles (50-100km)

Development and Service

Designed for all weather air-to-air and surface-to-air operations, Aspides will be carried by the F-104S interceptor and its successors, and will be employed in the Albatros naval point defence weapon system and Spada low-altitude air defence system. In the air-to-air role Aspide can operate successfully from very high to very low altitude and can be installed in any modern high-performance interceptor. It offers multiple target engagement capability and resistance to advanced ECM.

The flight test programme of the Aspide missile began with a captive flight on an F-104S on 24 July 1974, at the Italian Air Force's experimental base at Pratica di Mare. The first ground-to-air firing, from a Spada launcher, followed in May 1975. In 1977 the final test phase was initiated, using 15 missiles, and production was expected to begin the same year.

Below: Aspide



Asroc (RUR-5A)

USA

Anti-submarine rocket. In service.

Prime contractor: Honeywell Inc
Powered by: Naval Propellant Plant solid-propellant rocket motor
Airframe: Cylindrical aluminium body, made in two halves and joining torpedo at front to motor at rear. Cruciform tail-fins
Guidance and Control: Missile follows unguided ballistic trajectory after launch, towards target position predicted by shipboard sonar.
Warhead: Alternative warheads include the General Electric Mk 44 Model 0 high-speed acoustic-homing torpedo, Aerojet-General Mk 46 Model 0 advanced acoustic-homing torpedo, Honeywell Mk 46 Model 1, or a nuclear depth charge developed by the Naval Weapons Center and Honeywell
Length: 15ft 0in (4.57m)
Body diameter: 1ft 0.75in (0.325m)
Fin span: 2ft 9.25in (0.845m)
Launch weight: 959lb (435kg)
Range: 1.25-6.2 miles (2-10km)

Above: Asroc on a modified Terrier twin-launcher.

Above right: Asroc launcher on board USS *Sampson*.

Development and Service

Asroc development began in June 1956, and production was started three years later after successful firing trials. The weapon has been operational on destroyers, escort ships and cruisers of the US Navy since the summer of 1961 and also arms ships of Brazil, Canada, West Germany, Greece, Italy, Spain, Taiwan, Turkey and Japan.

In action, the target submarine's course, range and speed are worked out by shipboard computer within seconds of its detection by sonar. The eight-round standard launcher, or two-round modified Terrier missile launcher is aligned into firing position. The ship's commander then selects the missile with the most appropriate warhead and fires it. En route to the target, the Asroc sheds its rocket motor at a predetermined signal. Later, a steel band holding the airframe together is severed by a small explosive charge. The airframe then falls away, allowing the depth charge to drop into the water or the torpedo to be lowered to the surface by parachute, the homing head being activated on submersion.

AS-X-9

USSR

Air-to-surface anti-radiation missile. Under development.

Range: estimated 50-56 miles (80-90km)

Development and Service

This anti-radiation missile is being developed to arm the Sukhoi Su-19 'Fencer' variable-geometry attack aircraft. No further information is available.

AS-X-10 and AS-X-11?

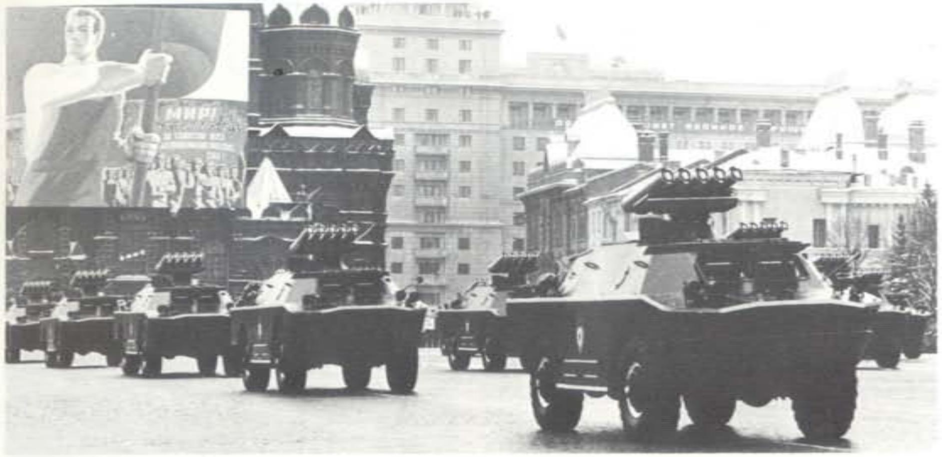
USSR

Development and Service

The AS-X-10 is reported to be an air-to-surface electro-optical homing missile, with a range of approximately 6.2 miles (10km). Another air-to-surface missile is under development in the Soviet Union, and has been referred to unofficially as the AS-X-11. In the USA it is officially referred to as the Advanced TASM tactical air-to-surface missile, and may have a range of about 25 miles (40km).

AT-5

USSR



Anti-tank missile. In service.

Above: AT-5s carried by BRDM-2 vehicles.

Guidance and Control: Command to line-of-sight guidance

Development and Service
The AT-5 is the latest of Soviet anti-tank missiles and was first seen at the November 1977 Moscow military parade. Five AT-5s are carried in canisters on a rotating launcher by the BRDM-2 vehicle. The launcher and missiles can be stowed internally when not required. It is thought that the new missile offers improved performance over earlier types, probably including a lower minimum range.

Atoll (AA-2; Soviet designation K-13A) and Advanced Atoll

USSR

Air-to-air missiles. In service.

Data: Atoll
Powered by: Solid-propellant rocket motor
Airframe: Cylindrical body. Cruciform triangular control surfaces near nose, indexed in line with fixed cruciform tail-fins
Guidance and Control: Infra-red homing guidance. Control by cruciform foreplanes and small gyroscopically-controlled tab at tip of trailing-edge of each tail-fin
Warhead: High-explosive
Length: 9ft 2in (2.80m)
Body diameter: 4.72in (0.12m)
Fin span: 1ft 8.75in (0.53m)
Span of control surfaces: 1ft 5.75in (0.45m)
Cruising speed: Mach 2.5
Range: approx 3-4 miles (5-6.5km)

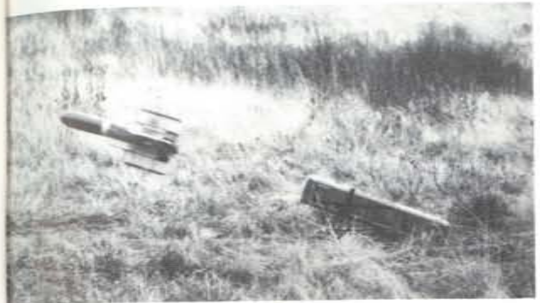
Development and Service
Soviet counterpart of the American Sidewinder and similar in configuration, size and guidance system. 'Atoll' is standard armament on Soviet Air Force and export versions of the MiG-21. It has also been produced in India to equip the MiG-21s of the Indian Air Force. Performance and capability are likely to be comparable with those of Sidewinder.

The latest multi-role versions of the MiG-21 carry four missiles on underwing pylons instead of the two 'Atolls' on earlier versions. The two additional weapons have radar homing guidance and are known at present as 'Advanced Atolls' to distinguish them from the original infra-red type.

Below: 'Atoll' under the wings of a MiG-21MF 'Fishbed-J'.

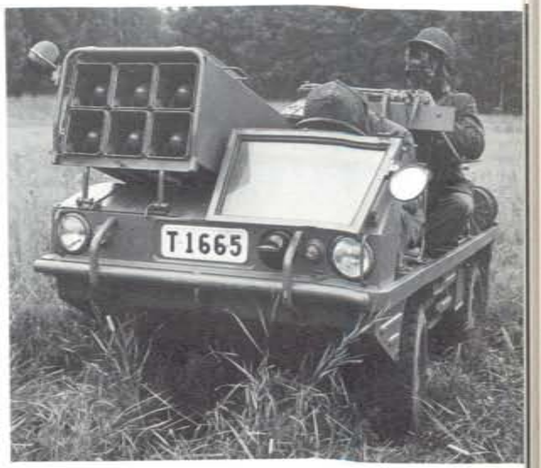
Bantam (RB53)

Sweden



Above: Bantam leaving its ground launcher.

Right: Bantam launch containers on a Puch-Haflinger jeep.



Light anti-tank missile. In production and service.

Prime contractor: Aktiebolaget Bofors
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical body, with rounded ogival nose and rear-mounted cruciform wings, made largely of glassfibre-reinforced plastics. Vibrating spoilers in trailing-edges of wings, which unfold as missile leaves container-launcher
Guidance and Control: Wire guidance via operator's joystick control. Missile is spin-stabilised by bent-over rear corners of wings. Control by vibrating spoilers
Warhead: Hollow charge, weighing 4.1lb (1.9kg)
Length: 2ft 9.5in (0.85m)
Body diameter: 4.3in (0.11m)
Wing span: 1ft 3.75in (0.40m)
Launch weight: 16.5lb (7.6kg)
Cruising speed: 190mph (306km/h)
Range limits: 985-6,600ft (300-2,000m)

Development and Service
Work on this very small wire-guided anti-tank missile was started as a private venture in 1956, with the aim of producing a weapon for operation by a single infantryman. Twelve can be carried in a state of instant readiness by the Puch-Haflinger light cross-country vehicle, each complete with a carrying rack in case they are needed for infantry use in combat areas. Bantams have also been launched successfully from light combat aircraft such as the Saab Supporter, and from helicopters.

Weight of the complete Bantam weapon system, including launcher, carrying rack, cable and control unit, is 44lb (20kg). Time required to set up the missile and fire it is about 25 seconds. Hit probability is claimed to be 95-98% over ranges between 2,625 and 6,600ft (800-2,000m). Contracts from the Swedish and Swiss Armies maintain production.

Bantams have also been ordered to arm Scottish Aviation Bulldogs (SK 61s) of the Swedish Air Force.

Bloodhound Mk 2 (Swedish Air Force designation RB68)

UK

Surface-to-air missile. In service.

Prime contractor: British Aerospace Dynamics Group
Powered by: Two Rolls-Royce Bristol Thor ramjet engines. Four jettisonable Bristol Aerojet solid-propellant boosters
Airframe: Cylindrical metal body with pointed ogival nose-cone. Pivoted mid-set wings, mid-way back on body and indexed in line with fixed horizontal tail surfaces. Ramjet engines carried on pylons above and below rear part of body. Equi-spaced wrap-round boosters, each with large stabilising fin
Guidance and Control: Semi-active radar homing, using Ferranti Firelight or GEC/AEI Scorpion target illuminating radar. Twist-and-steer control by means of wings, which can pivot both differentially and together
Warhead: High-explosive, with proximity fuse
Max length: 27ft 9in (8.46m)
Max body diameter: 1ft 9.5in (0.546m)
Wing span: 9ft 3.5in (2.83m)
Range: over 50 miles (80km)

Above left: Bloodhound 2s.

Above: Bloodhound 2 during booster separation

Development and Service

Bloodhound was developed originally by The Bristol Aeroplane Co Ltd, under the code-name Red Duster, as the standard RAF home defence missile. The original Mk 1 version became the first British weapon in this category to enter service, in mid-1958. It was replaced subsequently by the Mk 2, as described above, with more powerful Thor ramjets and boosters, CW (continuous wave) radar guidance, longer range, greater lethality and improved effectiveness at low altitudes. Tests showed that Bloodhound 2 could destroy fast targets at heights below 1,000ft (300m). Its air transportability was such that it could be used to reinforce overseas commands and, in fact, the missile was deployed by the RAF in Malaysia from the autumn of 1964. When British forces left the area, these weapons were taken over by the Singapore Air Defence Command. Other operators of Bloodhound 2 are Sweden and Switzerland.

RAF Strike Command continues to deploy Bloodhound Mk 2 in the UK.

Blowpipe

UK

Shoulder-fired close-range surface-to-air missile. In production and service.

Prime contractor: Short Brothers Ltd
Powered by: Two-stage solid-propellant rocket motor. First stage ejects missile from container. Second stage ignites after missile has coasted safe distance from operator
Airframe: Slim cylindrical body with long ogival nose-cone. Cruciform delta-shape control surfaces on nose, and cruciform delta tail-fins mounted on a sliding ring which locks into position at launch
Guidance and Control: Radio command guidance. Control by means of foreplanes
Warhead: High-explosive, with proximity fuse
Length: 4ft 5.1in (1.35m)
Body diameter: 3in (76mm)
Fin span: 10.8in (0.274m)
Weight of complete system, with missile: 42.75lb (19.4kg), or 46.75lb (21.2kg) with IFF

Development and Service

Shorts initiated development of Blowpipe as a private venture, using a similar command link guidance system to that which had proved so successful with Seacat and Tigercat. Small enough to be carried by a paratroop, fired from the shoulder and air-dropped in a multi-round pack, the weapon system consists only of the missile itself in a transport/launch container and an aiming unit attached to the container. All equipment is packed into the aiming unit, including the monocular sight and thumb-operated joy-stick by which the Blowpipe missile is guided to the target. Acquisition of the target and firing can be as little as four seconds. As the missile leaves the end of the container, the tail-fin assembly housed in the front of the tube slides along the missile body and locks into place. This enables the diameter of the main part of the container to be kept to a minimum.

Blowpipe can be used against both attacking and receding aircraft and is the only weapon of its kind which is effective in the forward quadrasphere. A fully integrated identification (IFF) system is an optional extra. It also has a surface-to-surface capability against light armoured vehicles and inshore craft. The missile is currently in service with British and Canadian armed forces and other undisclosed countries. A naval application is in the Vickers Ship Building Group's SLAM submarine-launched missile system (qv).

Bullpup A (AGM-12B/E)

USA

Air-to-surface tactical missile. In service.

Prime contractors: Martin Marietta Corporation/Maxson Electronics Corporation/Kongsberg Vaapenfabrikk
Powered by: Thiokol LR58-2 storable liquid-propellant rocket motor, of 12,000lb (5,440kg) st
Airframe: Cylindrical body with pointed ogival nose and tapered tail. Rear-mounted cruciform wings indexed in line with cruciform delta control surfaces on nose-cone
Guidance and Control: Radio command guidance. Control by foreplanes
Warhead: High-explosive, weighing 250lb (113kg). Fragmentation in AGM-12E
Length: 10ft 6in (3.20m)
Body diameter: 1ft 0in (0.305m)
Wing span: 3ft 1.5in (0.95m)
Launch weight: 569lb (258kg)
Cruising speed: Mach 1.8
Max range: 7 miles (11km)

Development and Service

Bullpup was conceived originally, under the US Navy designation ASM-N-7, as a simple weapon built around a standard 250lb bomb and powered by a solid-propellant motor developed by the Navy. The pilot of the launch aircraft steered it in flight by movements of a hand switch in the cockpit, using tracking flares above and below the rocket nozzle as a reference in order to keep Bullpup on a line-of-sight path to the target. This original version became operational on 25 April 1959, and was later redesignated AGM-12A. It was superseded by the AGM-12B (formerly ASM-N-7A) for the US Navy, with storable liquid-propellant engine, improved warhead and extended range control; and the USAF AGM-12B (GAM-83A) with a modified guidance system which permitted pilots to make their attacks from an offset position in relation to the target.

Production was undertaken initially by Martin Marietta, who had developed Bullpup A from design study to flight test in under two years. Maxson was brought in as second-source supplier to meet demands for the weapon and eventually took over all US Bullpup production. Licence manufacture in Europe was handled by a consortium led by AS Kongsberg Vaapenfabrikk of Norway, for the armed services of Denmark, Norway, Turkey and the UK. Aircraft armed with Bullpup have included the US Navy's A-4, A-5, A-6, A-7, F-8E and P-3B; the USAF's F-4, F-100 and F-105, and the Royal Navy's Buccaneer.

The final version of Bullpup, produced on a limited basis by Martin Marietta for the USAF, was the AGM-12E with an anti-personnel warhead for use in Vietnam.

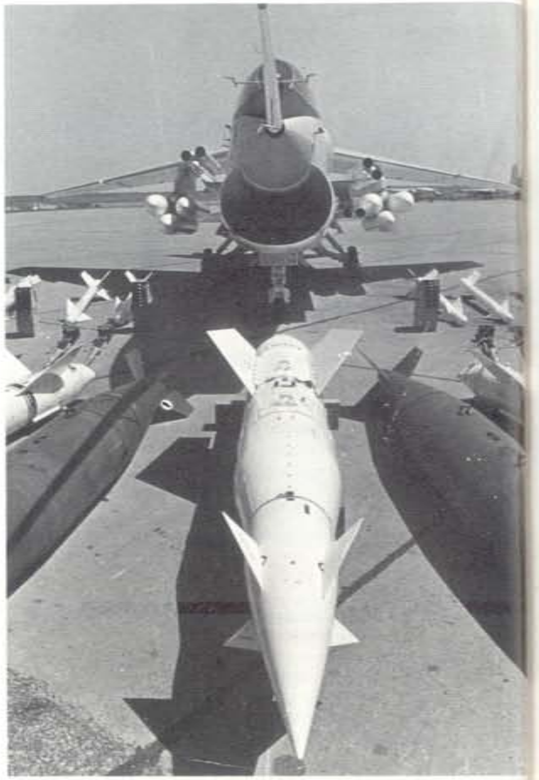
Bullpup B (AGM-12C/D)

USA

Air-to-surface tactical missile. In service.

Data: AGM-12C
Prime contractor: Martin Marietta Corporation/Maxson Electronics Corporation
Powered by: Thiokol LR62 storable liquid-propellant rocket motor
Airframe: Basically cylindrical body, tapering towards nose and tail. Pointed ogival nose-cone, with cruciform delta control surfaces, mounted on front of body. Rear-mounted cruciform wings indexed in line with foreplanes
Guidance and Control: Radio command guidance. Control by foreplanes
Warhead: High-explosive (AGM-12C), or alternative high-explosive or nuclear (AGM-12D)
Length: 13ft 4.25in (4.07m)
Body diameter: 1ft 5.25in (0.44m)
Wing span: 3ft 10.5in (1.18m)
Launch weight: 1,790lb (812kg)
Range: 10 miles (16.5km)

Development and Service
Bullpup A proved such an effective weapon that the US Navy sponsored the development of a version with much extended capabilities, built around a 1,000lb (454kg) high-explosive warhead. Known as Bullpup B, this went into production for the Navy under the designation ASM-N-7B, changed after a time to AGM-12C, and augmented rather than replaced Bullpup A. The USAF acquired a version designated AGM-12D (originally GAM-83B), with interchangeable nuclear and high-explosive warheads.



Right: Bullpup B.

Carcara

Brazil

Air-to-surface missile. Under development

Prime contractor: Avibras-Industria Aerospacial
Guidance: Television guided

Development and Service
Carcara was reported to be under development for the Brazilian Army. It is not known if the project is continuing or whether it has already been abandoned.

Chaparral (MIM-72A)

USA

Surface-to-air weapon system. In production and service.

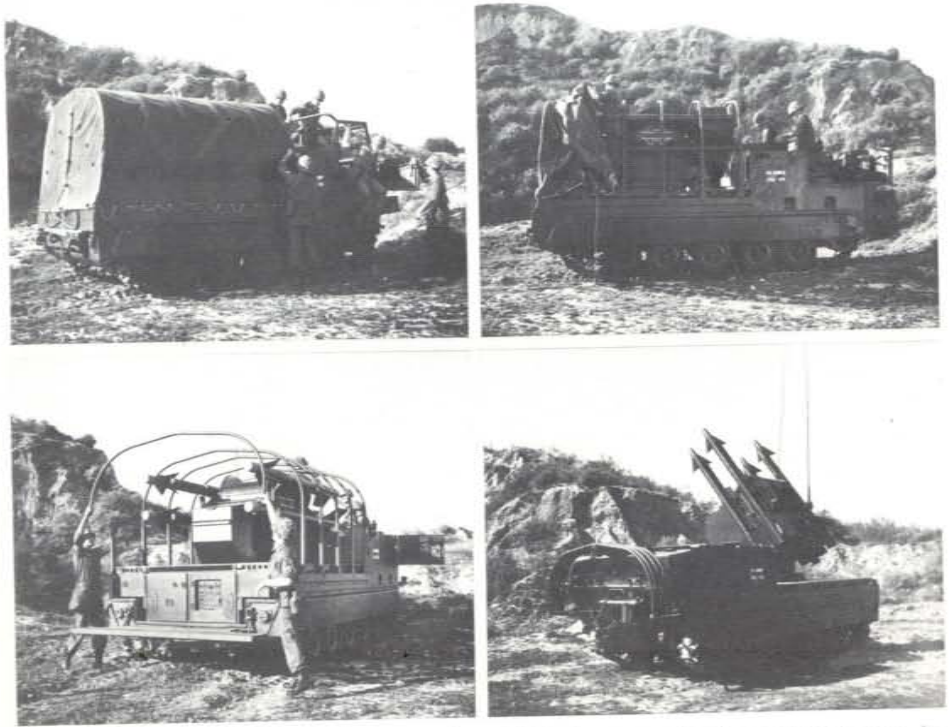
Prime contractor: Ford Aerospace and Communications Corporation, Aeronutronic Division
Guidance and Control: Infra-red homing guidance. Control by cruciform foreplanes
Length: 9ft 6in (2.90m)
Body diameter: 5in (0.13m)
Span of tail-fins: 2ft 0in (0.61m)
Launch weight: 190lb (86kg)

Development and Service
Chaparral is a close-range battlefield weapon system which uses Sidewinder 1C missiles modified for a surface-to-air role. Four Sidewinders are mounted in ready-to-fire condition on a fire unit which is normally installed on an M730 self-propelled tracked vehicle; alternatively the fire unit can be trailer-mounted or dismounted for use from a semi-mobile emplacement (system designation is M48 Guided Missile System, Intercept, Aerial). Initial aiming is done by a gunner in the fire unit turret mount, who keeps an optical sight aligned on target. After launch, the missile's own infra-red homing system takes over.

Development of Chaparral began in the spring of 1965. Test firings from prototype fire units started in July of that year and production was initiated in 1966 for the US Army's then-new air defence battalions, each of which has two batteries of Chaparrals and two of Vulcan multi-barrel 20mm guns. The five-man crew of an M48 has rations and equipment for at least three days of autonomous operations and can travel at up to 40mph (64km/h) on roads. Only one man is required to fire the missiles, of which 12 are carried; the others keep watch for hostile aircraft.

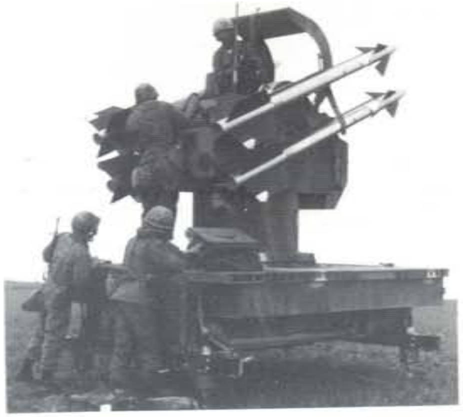
The first phase of a phased improvement programme consisted of upgrading the missile by addition of a new guidance unit, fuse and warhead to provide a much greater capability. These missile improvements entered production in 1975.

In 1978 five successful test firings of Chaparral missiles guided by radar were undertaken against an MQM-107 target drone and a drone helicopter. The tests demonstrated that the missile, with an additional command guidance module, can be accurately guided by a tracking radar to give the Chaparral system night and adverse weather capability.



Above: Chaparral mounted on an M730 tracked vehicle.

Below: Chaparral air-defence missile system.



Chinese anti-ship missile

China

A new Chinese anti-ship missile has become operational on Hai Dua class boats, the first of which was built in 1976.

Chinese ICBMs (CSS-3 and CSS-X-4)

China

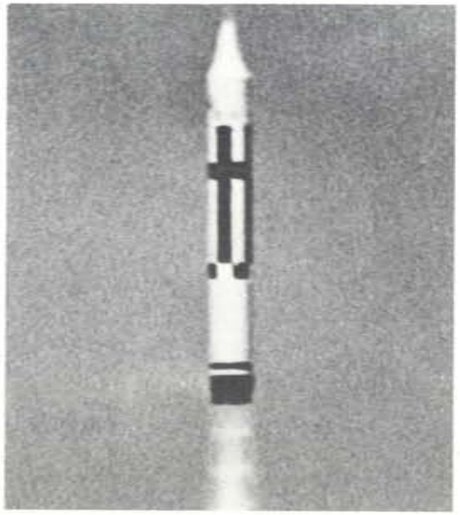
Land-based intercontinental ballistic missiles.

Warhead: Nuclear

Development and Service
There are two Chinese ICBMs. The CSS-3 limited-range ICBM was flown under test conditions in 1976 and only a small number are expected to be deployed. The long-range CSS-X-4 ICBM is under development and could be deployed during the first half of the 1980s.

China achieved its first successful firing of an ICBM in late 1970. The range of the missile, which carried an inert warhead, was restricted deliberately to 2,000 miles (3,200km), so that the test could be confined within the nation's own borders. Further flight tests took place in 1973.

The CSS-3 is thought to have a range of about 3,500 miles (5,630km). This makes it capable of reaching well into the Soviet Union, but only to western Alaska in the USA. The CSS-X-4 long-range ICBM is still being developed, and has been used successfully as a satellite launch vehicle. Assuming a range of 7,456 miles (12,000km), it will be capable of reaching major cities in the USA and could have a megaton yield warhead.



Above: Launch of a Chinese ICBM.

Chinese IRBM (CSS-2)

China

Intermediate-range ballistic missile. In service.

Powered by: Single-stage liquid-propellant motor
Warhead: Nuclear
Range: approx 1,555-2,485 miles (2,500-4,000km)

Development and Service
Chinese CSS-2 ICBMs have been deployed operationally since 1971. It is thought that between 20 and 30 are operational. CSS-2s are capable of reaching targets in central and eastern Asia.

Chinese MRBM (CSS-1)

China

Medium-range ballistic missile. In production and service.

Powered by: Single-stage liquid-propellant motor
Warhead: Nuclear
Range: approx 685-1,118 miles (1,100-1,800km)

Development and Service
US Secretary of Defense Melvin R. Laird said in February 1970 that China was expected to deploy its first medium-range ballistic missiles (MRBMs) 'at any time' and that 80-100 of the weapons would probably be operational by the mid-1970s. Deployment may have been a little slower than expected, as reports suggest that only 50 operational CSS-1 MRBMs and a smaller number of IRBMs were available for use, in about four launch areas, by 1974. The latter are generally soft sites, above ground, but some missiles are reported to be stored in silos and caves. The warheads for long range rockets have been under development since the first Chinese explosion of a 20-kiloton nuclear device at Lop Nor in the Sinkiang desert on 16 October 1964. The fourth such test, in October 1966, was claimed to involve delivery of the warhead to a target area by a missile — thought to have been based on a Soviet weapon like 'Sandal'. The MRBM is probably similar. It was described by General George S. Brown, Chairman of the US Joint Chiefs of Staff, in 1976, as 'based on the Soviet SS-2, obsolescent, cumbersome, with slow reaction time'.

Chinese SLBM

China

Submarine-launched ballistic missile. Under development.

Development and Service
Reports have suggested that China is developing a two-stage solid-propellant SLBM in approximately the same class as the early Polaris. A purpose-built nuclear submarine is also likely to be under development to supplement China's single Soviet 'Golf' class ballistic missile submarine, which has three vertical missile tubes but may not be armed with missiles at present.

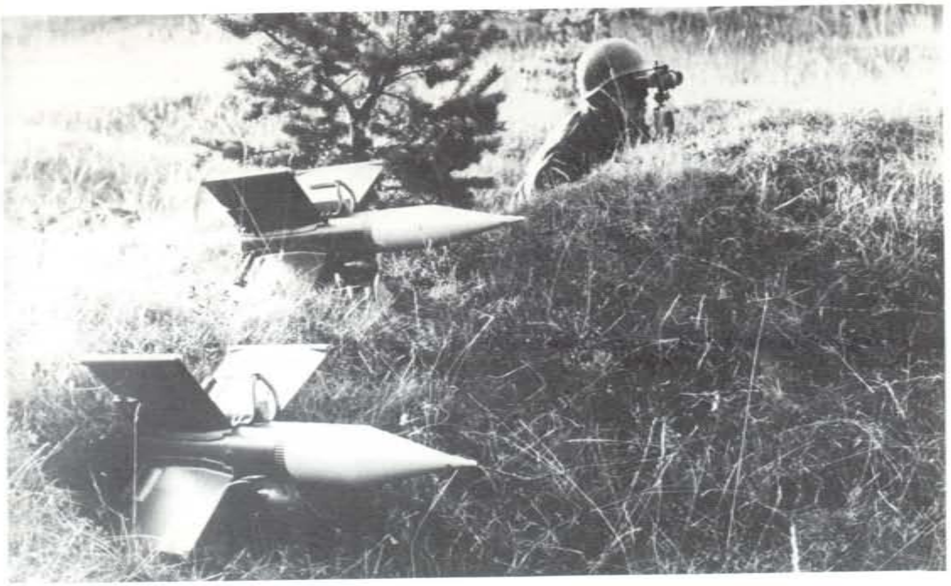
Chinese surface-to-air missile

China

Development and Service
The Chinese frigate *Kiangtung*, built in 1977, carries close-range surface-to-air missiles of similar size to the Soviet 'Goa'. It is unknown whether this is a newly designed missile or not.

Cobra 2000 (BO810)

Germany



Lightweight anti-tank missile. In production and service.

Prime contractor: Messerschmitt-Bölkow-Blohm GmbH
Powered by: Solid-propellant sustainer rocket motor. Non-jettisonable solid-propellant booster rocket
Airframe: Cylindrical fibre-paper body, with pointed conical nose. Large plastic cruciform wings, each with spoiler. Booster mounted under body
Guidance and Control: Wire guidance by line-of-sight command, via operator's joystick controller. Control by spoilers in wings
Warhead: Hollow charge, weighing 6lb (2.7kg) and able to penetrate more than 18.7in (475mm) of steel armour. Alternative anti-tank shrapnel (ATS) warhead
Length: 3ft 1.5in (0.95m)
Body diameter: 3.9in (0.100m)
Wing span: 1ft 7in (0.48m)
Launch weight: 22.7lb (10.3kg)
Max speed: 190mph (306km/h)
Range limits: 1,310-6,560ft (400-2,000m)

Development and Service

This one-man anti-tank weapon system first entered service in 1960, and comprises the Cobra missile, a control box and cable links, with a junction box connected. Up to eight rounds can be fired selectively from a single control box. No launcher is required as the missile is designed for jump launching from the ground. The control box is completely self-contained and carries the firing button and control stick.

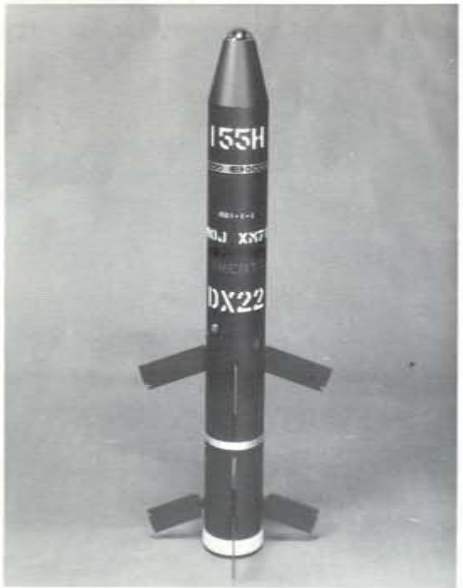
More than 170,000 Cobras have been delivered to the armies of Germany and many countries within and outside NATO. Manufacturing licences have been granted to Brazil, Italy, Pakistan and Turkey. The current version is known as the Cobra 2000 to indicate the extension of its maximum range to 2,000m.

Copperhead

USA

Anti-tank projectile. Under development.

Prime contractor: Martin Marietta Corporation
Airframe: Cylindrical body with cruciform flip-out narrow chord wings and tail-fins indexed in line
Guidance and Control: Laser-guided. Control via tail-fins
Warhead: High-explosive, weighing 14.1lb (6.4kg)
Length: 4ft 6in (1.37m)



Launch weight: 140lb (63.5kg)
Range limits: 1.8-12.4 miles (3-20km)

Development and Service

Copperhead (XM712) is a Cannon-Launched Guided Projectile (CLGP). It has a laser seeker and is fired from existing 155mm howitzers, such as that fitted to NATO's self-propelled M-109A1, against all types of armoured and artillery targets marked by a laser designator. This gives Copperhead an advantage over ordinary 155mm artillery rounds in that it allows a high chance of a single shot kill, while the gun remains miles from the target. As an alternative, and in order to do away with the need for the ground observer/operator operating the laser designator in line-of-sight with the target, the designator can be carried in a helicopter (with all appropriate subsystems) or by a remotely-piloted vehicle.

First conceived in 1970, Copperhead subsequently made six direct hits against stationary and moving targets at various ranges, using a ground laser designator, during competitive trials. The full-scale development programme was initiated in July 1975 and in October of the same year a Copperhead made a successful attack on a target while guided by a laser designator in an RPV. In February 1976, another successful attack was made by a Copperhead, this time fired at night and with the designator on board a Bell HueyCobra helicopter. The production decision was expected in 1979.

Below: Copperhead strikes home.

Crotale/Cactus

France

Close-range surface-to-air missile. In production and service.

Prime contractor: SA Engins Matra
Powered by: Single-stage SNPE Lens solid-propellant rocket motor
Airframe: Slim cylindrical body, with cruciform foreplanes mounted on ogival nose-cone and indexed in line with cruciform tail surfaces
Guidance and Control: Radio command guidance
Warhead: High-explosive, weighing 33lb (15kg) with infra-red proximity fuse
Length: 9ft 5.75in (2.89m)
Body diameter: 5.9in (0.15m)
Wing span: 1ft 9.25in (0.54m)
Launch weight: 187lb (85kg)
Max speed: Mach 2.3
Range limits: 1,640ft-5.3 miles (500m-8.5km)

Development and Service

Matra designed this highly-mobile all-weather missile to deal with aircraft flying at speeds up to Mach 1.2 at any height from 165ft (50m) to 9,850ft (3,000m) with a reaction time of only six seconds. Work on the missile started in 1964 and the prototype was completed in 1965, Matra being responsible for the missile and Thomson-CSF for development of the system. Manufacture of the complete system started in late 1968, but no information was released publicly until May 1969, when the South African Defence Minister announced that French companies were developing for his country a weapon known as Cactus; it was later revealed that this weapon was known as Crotale in France. In 1969 successful launches were made at Landes, against target drones. Deliveries to South Africa began in late 1971, and the French Air Force uses Crotale systems for airfield defence. The missile system is thought to have also been ordered by Abu Dhabi, Egypt, Libya, Kuwait, Pakistan and Spain. Thomson-CSF has also adapted this weapon for a ship-based role (see Naval Crotale).

Right: Crotale missile in its launcher.

Below: Crotale launch vehicle armed with three missiles.

Four Crotale/Cactus missiles are carried in ready-to-fire condition on the standard Hotchkiss-Brandt all-terrain launch vehicle. This carries also a monopulse fire control radar which can track and transmit command signals simultaneously to two missiles. Acquisition after launch is facilitated by an infra-red device which locks on to the missile exhaust. An optical tracking device is also provided. An integrated TV tracking mode provides back-up guidance at low level. A second vehicle of the same type carries a pulse-Doppler surveillance and target acquisition radar with a range of 11.5 miles (18.5km), and can serve three launch vehicles. Twelve targets can be tracked simultaneously, and 12 missiles can be launched in pairs at six targets in 11 seconds.

Cruise missiles

UK/France/Germany

Air-launched cruise missiles. Possibly under development.

Development and Service

The UK, France and Germany are reported to be looking into the possibility of developing cruise missiles, in the case of the UK and France as possible replacements for submarine-launched ballistic missiles as their main strategic weapons for the mid-1980s.

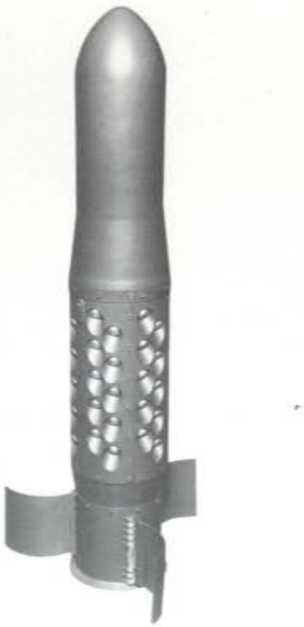
Dragon (M47)

USA

Medium anti-tank and assault missile. In production and service

Prime contractor: McDonnell Douglas Astronautics Company

Powered by: 30 pairs of small solid-propellant rocket motors, in rows around body



Airframe: Cylindrical body, of reduced diameter at nose and tail, with rounded nose. Three curved tail-fins which flip open after launch

Guidance and Control: Wire guidance, by automatic command-to-line-of-sight system. Control by side-thrusters around body

Warhead: High-energy anti-tank

Length: 2ft 5.3in (0.74m)

Fin span: 1ft 1in (0.33m)

Launch weight: 27lb (12.25kg)

Range limits: 164-3,280ft (50-1,000m)

Development and Service

Dragon was projected to replace the 90mm recoilless rifle, to which it is superior in range and accuracy. It was known initially as MAW (Medium Anti-tank/assault Weapon) and is able to carry a warhead large enough to destroy most armoured and other infantry targets, while being light enough to be carried and shoulder-fired by one man. In operation, the infantryman first mounts on the missile launch-tube a tracker, embodying the telescopic sight, a sensor device and electronics package. The glassfibre launch-tube forms a sealed container for the missile during transport and storage, and is enlarged at the aft end to accommodate a propellant container and breech. After acquiring the target in the sight, the operator launches the Dragon missile. As long as the sight remains on the target, the tracker will sense the position of the missile relative to the line of sight and transmit signals to maintain or correct the flight path. 'Steering' is achieved by causing the appropriate pairs of rocket motors, or side thrusters, to fire for both propulsion and guidance.

Left: Dragon.

Left: Dragon launcher.

Development of the Dragon weapon system was started in 1964. Manned shoulder-fired tests began in mid-1968, and service testing in 1972. Dragon entered production in FY 1972. In September 1972, Raytheon Company won a contract as an alternate source for the Dragon. First deliveries by Raytheon were made to the US Army at the beginning of 1974, and deliveries continue. The US Army, Marine Corps, National Guard and forces of several other countries are now equipped with Dragon. A night tracker and a viscous damped mount are also under development for use with the missile.

Entac (MGM-32A)

France

Anti-tank missile. In service.

Prime contractor: Nord-Aviation/Aérospatiale, Division Engins Tactiques

Powered by: Two-stage solid-propellant rocket motor

Airframe: Cylindrical body with rounded ogival nose. Rear-mounted cruciform wings, each with a spoiler

Guidance and Control: Wire-guided and roll-stabilised. Control by wing spoilers

Warhead: High-explosive, weighing 9lb (4.1kg) and able to penetrate more than 25.5in (650mm) of steel armour

Length: 2ft 8.5in (0.82m)

Body diameter: 6in (0.15m)

Wing span: 1ft 3in (0.38m)

Launch weight: 26.9lb (12.2kg)

Max speed: 190mph (305km/h)

Range limits: 1,300-6,600ft (400-2,000m)

Development and Service

One of the first wire-guided anti-tank missiles to enter large-scale production, Entac (ENgin Téléguidé Anti-Char) was adopted in its Model 58 form by the French Army in 1957. Over 139,417 have been delivered to the armies of 13 countries, including Australia, Belgium, Canada, Indonesia and the USA. Entac is known as the MGM-32A by the US Army. Production has now ended.

Entac is intended primarily for use by infantry and was developed by the Direction Technique des Armements Terrestres (DTAT). An operator can control and fire up to 10 missiles from a single firing post, with a maximum operator-to-missile distance of 360ft (110m). Alternatively, four Entacs can be mounted in pairs on each side of a jeep, inside their box-like container-launchers. The operator uses an optical sight to locate and track the target and a manual control to command the missile on to his line-of-sight.

Below left: Entac missile mounted on a jeep.

Below: Ground-launched Entac.

Exocet (MM38, AM39 and MM40)

France

Ship-launched and air-launched anti-ship tactical missile. In production and service.

Data: AM39
Prime contractor: Aérospatiale, Division Engins Tactiques
Powered by: Tandem two-stage solid-propellant motor; burn time 2sec and 150sec respectively
Airframe: Cylindrical body, with pointed ogival nose. Cruciform sweptback wings, indexed in line with cruciform tail control surfaces
Guidance and Control: Inertial guidance system, associated with TRT AHV-7 FM radio-altimeter, and with active terminal homing radar. Control by tail surfaces
Warhead: High-explosive, weighing 352lb (160kg)
Length: 15ft 4.25in (4.68m)
Body diameter: 1ft 1.75in (0.348m)
Wing span: 3ft 3.5in (1.00m)
Launch weight: 1,433lb (650kg)
Cruising speed: Mach 0.93
Range: 32.25-43 miles (52-70km)

Development and Service

Following the sinking of the Israeli destroyer *Eilat* by 'Styx' ship-to-ship missiles, it became a matter of high priority to evolve a defence against such attack. Once missiles like 'Styx' have been launched they are difficult to intercept. In consequence, Nord-Aviation (now Aérospatiale) concentrated on producing a weapon that would sink enemy missile-armed boats before they were near enough to launch their own attack. Exocet is the answer to that requirement and is one of the most formidable naval weapons ever conceived, being able to travel to the target only 6.5-10ft (2-3m) above the water, in all weathers, at just below the speed of sound. An oncoming Exocet would thus be extremely difficult to detect by shipboard radar, and it is designed to be impervious to enemy electronic countermeasures (ECM).

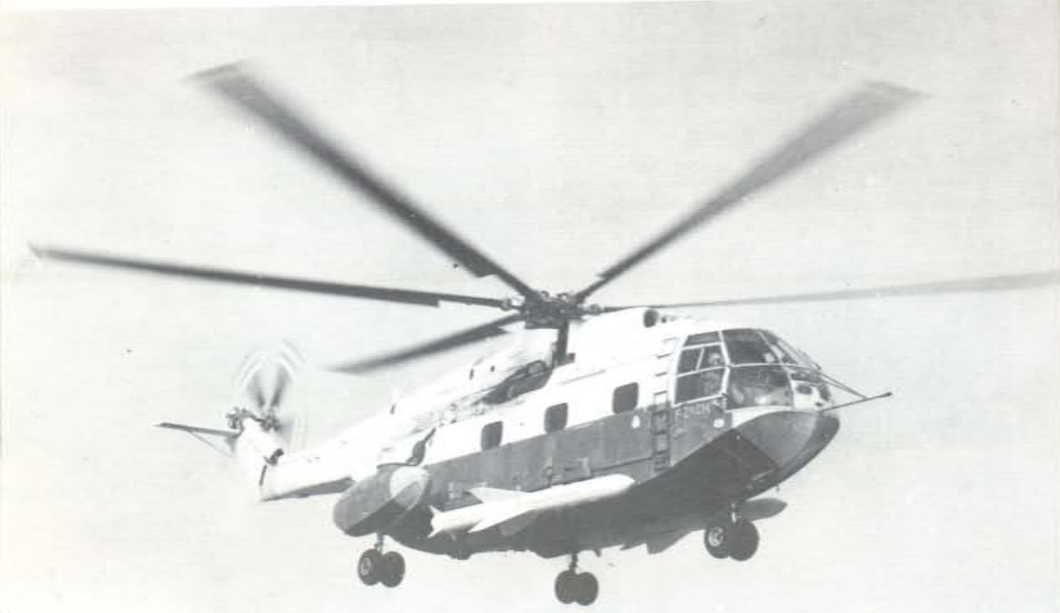
The basic MM38 Exocet weapon system can be fitted to any class of surface warship, including fast patrol boats, provided the ship is fitted with surveillance and target indicating radar, a vertical reference plane gyro and a log to indicate its speed through the water, plus a fire control system. The range and bearing of the target are fed into the missile's guidance system before launch; its cruising height is maintained at very low level by a radio-altimeter linked to its controls.

Evaluation by the French Navy began in October 1972, with the Royal Navy and West German Navy participating. Production for these countries started in January 1973. The 100th MM38 was launched in October 1978. Development of Exocet for an air-to-surface role followed. Air-launch tests began in April 1973 from a Super Frelon helicopter. The missile used was a modified MM38 called AM38, which incorporated a one-second ignition delay to permit the weapon to fall clear of the launch aircraft before firing. A similar delay is incorporated into the AM39 air-to-surface Exocet that was first fired from a Super Frelon in December 1976 and from a Super Etendard in 1977. Production began in 1977 for the French Navy and for export. The AM39 is shorter and lighter than the MM38 and has a new motor which gives it a range of 32.25miles (52km) when launched from a helicopter at 69mph (110km/h) at a height of 330ft (100m), or 37-43 miles (60-70km) when launched from a Super Etendard at 330-33,000ft (100-10,000m). As well as being carried by the French Navy's Super Etendard aircraft, it will also arm the Mirage F1, and can be installed on some helicopters.

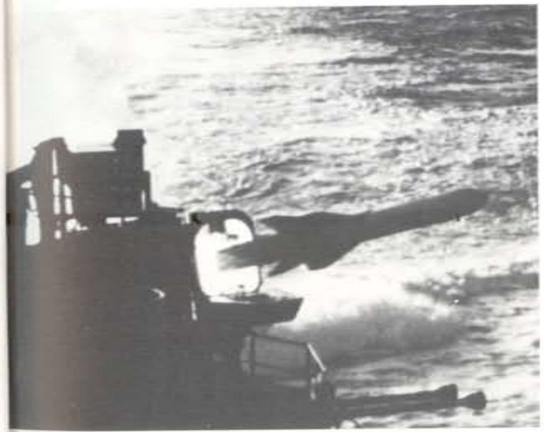
More than 1,100 MM38/AM39s have been ordered by the three navies mentioned above and those of Argentina, Belgium, Brazil, Chile, Ecuador, Greece, Indonesia, Iraq (AM39), Kuwait, Malaysia, Morocco, Nigeria, Pakistan (AM39), Peru, Portugal and Thailand.

Proposed new versions of Exocet include the MM39, MM40 and SM39. However, only the longer range MM40 (which can be ship or coastal defence land vehicle mounted in four-round launchers) is being developed at a serious pace — the MM39 having been abandoned and the SM39 submarine-launched version receiving only limited interest.

Below: Exocet test round on a Super Frelon helicopter.

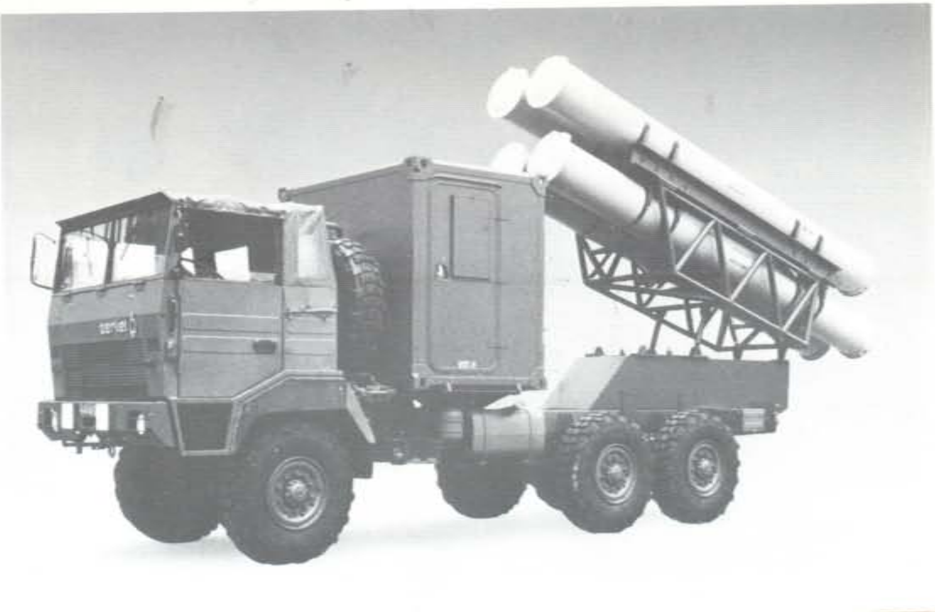


Below: Exocet MM38 ship-launched missile.



Right: Six Exocet MM38 launchers forward of superstructure on the French Navy's *Jeanne d'Arc*.

Bottom: Exocet MM40 coastal defence vehicle.



Falcon (AIM-4D)

USA

Air-to-air missile. In service.

Prime contractor: Hughes Aircraft Company
Powered by: Thiokol M58-E4 solid-propellant rocket motor of 6,000lb (2,720kg) st
Airframe: Cylindrical body with tapered and rounded glass-tipped nose. Cruciform vanes aft of nose, indexed in line with long-chord cruciform delta wings. Cruciform tail control surfaces aft of wing trailing-edges
Guidance and Control: Infra-red homing guidance. Control by tail surfaces
Warhead: High-explosive
Length: 6ft 7.5in (2.02m)
Body diameter: 6.4in (0.163m)
Wing span: 1ft 8in (0.51m)
Launch weight: 134lb (61kg)
Max speed: Mach 4
Max range: 6 miles (9km)

Above: AIM-4D Falcons.

Development and Service

Hughes began work on the original GAR-1 semi-active radar homing version of Falcon in 1947. The first of about 4,000 production models appeared in 1954, followed by more than 12,000 improved GAR-1Ds (later redesignated AIM-4As). Simultaneously, the company delivered about 16,000 GAR-2s and 9,500 GAR-2As, with pursuit-course infra-red homing. Later redesignated AIM-4C, these offered the advantage that the launch aircraft was free to break off the engagement once the self-homing missiles had been launched. The final production version of this basic Falcon family was the AIM-4D, combining the basic airframe of the 'C' with the improved infra-red homing head of the AIM-4G Super Falcon. Many thousands of older Falcons were converted into 'Ds', which continue to arm F-101 interceptors of the Canadian Armed Forces (the only aircraft now armed with early version Falcons). Under a 1969 USAF contract, Hughes evolved the AIM-4H with a new warhead incorporating an active optical target detection device (AOTDD). A solid-state laser device in the AOTDD detonated the warhead without requiring a direct hit, making the 'H' better suited to close air combat. However, US budget economies precluded further development and production. (See also HM-58 and Super Falcon.)

Falcon (HM-55/HM-58) (Swedish Air Force designations RB27 and RB28)

USA

Air-to-air missiles. In production and service.

Prime contractors: Hughes Aircraft Company/Saab-Scania Aktiebolag
Powered by: Single-stage solid-propellant motor
Guidance and Control: HM-55 has Hughes semi-active radar homing guidance; HM-58 uses infra-red homing system
Warhead: High-explosive, RB27 with proximity fuse
Length: RB27 7ft 1in (2.16m)
RB28 6ft 7.5in (2.02m)
Max body diameter: RB27 11in (0.28m)
RB28 6.4in (0.163m)
Wing span: RB27 2ft 0in (0.61m)
RB28 1ft 8in (0.51m)
Launch weight: RB27 262lb (119kg)
RB28 134lb (61kg)
Max speed: RB27 Mach 3
RB28 Mach 4
Max range: RB27 6.2miles (10km)
RB28 5.6 miles (9km)

Bottom left: Two RB27 (HM-55) missiles under the fuselage of a J35F Draken.

Development and Service

The HM-55 and HM-58 export versions of the Falcon are built under licence in Sweden by Saab-Scania, under the Swedish Air Force designations RB27 and RB28 respectively. In general appearance the HM-55 resembles the AIM-26B Falcon (qv). Its all-weather guidance system makes possible attack from any direction, including head-on, and its launch speed makes it compatible with Mach 2 aircraft. The Swedish Air Force deploys it on J35F Draken interceptors in combination with the HM-58. This is an infra-red homing weapon generally similar to the AIM-4D Falcon. The Swiss Air Force has also adopted the HM-55 as standard armament for its Mirage IIIS fighters.

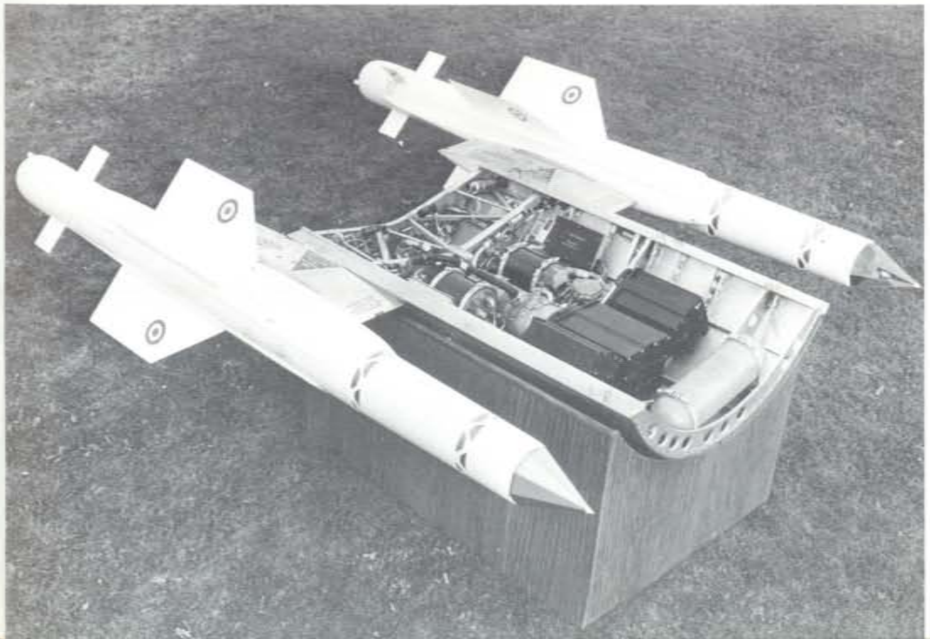
Firestreak

UK

Air-to-air missile. In service.

Prime contractor: British Aerospace Dynamics Group
Powered by: Solid-propellant rocket motor
Airframe: Cylindrical metal body, with cruciform wings mounted more than half-way back from nose and indexed in line with cruciform tail control surfaces. Pointed eight-sided glass nose, with two narrow rings of small windows over infra-red optics on fore-part of body
Guidance and Control: Infra-red homing guidance. Control by tail-fins
Warhead: High-explosive, weighing 50lb (22.7kg), with infra-red proximity fuse
Length: 10ft 5.5in (3.19m)
Body diameter: 8.75in (0.225m)
Wing span: 2ft 5.5in (0.75m)
Launch weight: 300lb (136kg)
Cruising speed: above Mach 2
Range limits: 0.75-5 miles (1.2-8km)

Below: Firestreak missile pack for a Lightning interceptor.



Development and Service
Firestreak was developed for use against high-speed and manoeuvring aircraft and is said to have achieved a success rate of more than 85% in trials by the RAF and Royal Navy at all altitudes and in all weather conditions. Control is by a proportional navigation system. The guidance system uses a gyro-mounted telescope which focuses infra-red radiation on to a detector cell. The angular difference between the axis of the homing head and the sight-line between the missile and target aircraft is then computed and corrections are made to reduce the angle and align the missile on target. Firestreak's only limitation is that it must be fired from astern the target — a shortcoming that does not apply to the further-developed Red Top (qv). It is standard armament on RAF Lightning interceptors.

FRAS-1

USSR

Anti-submarine rocket. In service

Warhead: Nuclear depth charge or torpedo
Range: approx 15.5 miles (25km)

Development and Service
This unguided anti-submarine weapon is similar in concept to the US Asroc.

Frog-3, 4 and 5

USSR

Unguided surface-to-surface bombardment missiles. In service.

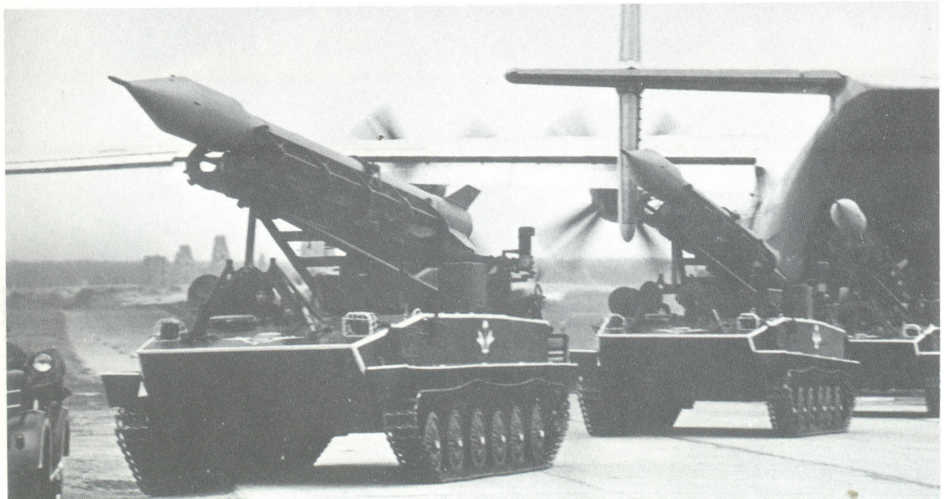
Data: 'Frog-4'
Powered by: Two-stage solid-propellant motors. 12 small nozzles around main nozzle of booster
Airframe: Tandem two-stage all-metal casings, of cylindrical shape. Conical nose-cone. Fixed cruciform tail-fins
Guidance and Control: No guidance system. Spin stabilised
Warhead: Alternative nuclear or high-explosive
Length: 33ft 6in (10.20m)
Body diameter: about 1ft 3.7in (0.40m)
Fin span: 3ft 6in (1.05m)
Launch weight: 4,400lb (2,000kg)
Max range: 30 miles (50km)

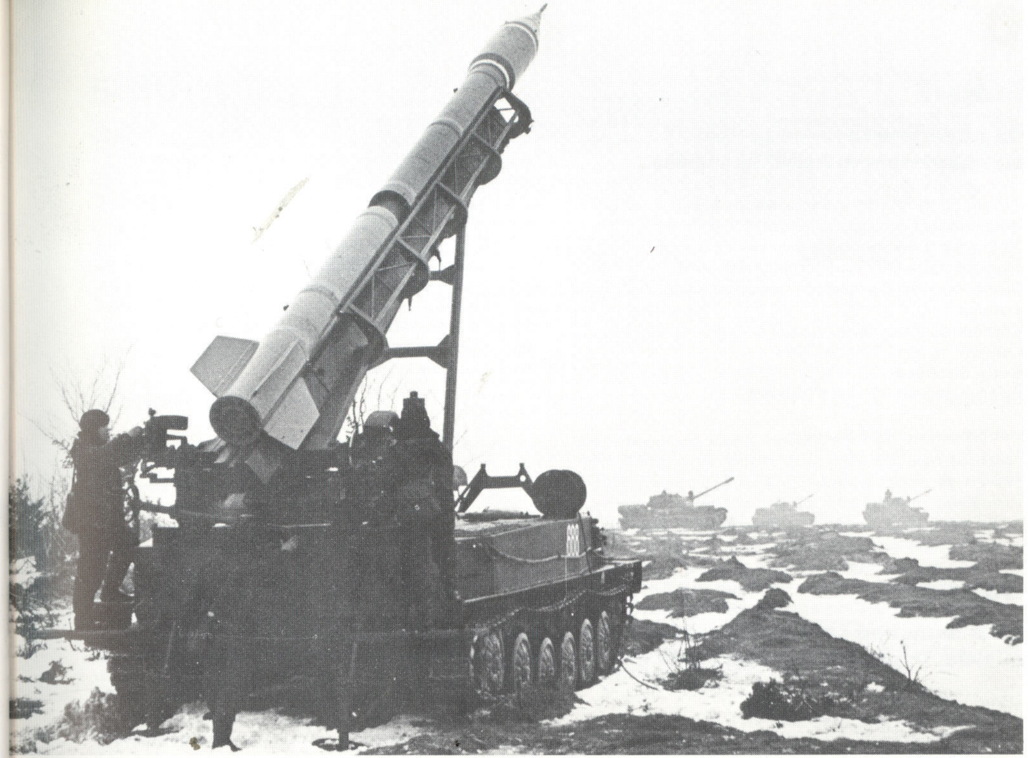
Development and Service
Like the earlier 'Frog-1 and 2', which are no longer in service, these missiles are all unguided artillery rockets; but have two stages in tandem and are carried on an uncovered launch rail by a tracked vehicle based on the PT-76 amphibious reconnaissance tank. (Frog is a NATO reporting name standing for Free Rocket Over Ground.) The 'Frog-2', of which eight were paraded through Moscow in November 1957, was followed successively by 'Frog-3', with a more cylindrical bulbous warhead, now considered obsolete; the 'Frog-4', differing only in having a warhead of the same diameter as the second-stage casing; and 'Frog-5' with yet another variation in warhead. The latter is also believed to be shorter than 'Frog-4', of greater body diameter, to be heavier and with increased range. These rockets were all delivered in large numbers to the Soviet Army and its Warsaw Pact allies. 'Frog-4' also serves in Cuba, and 'Frog-5' possibly in North Korea.

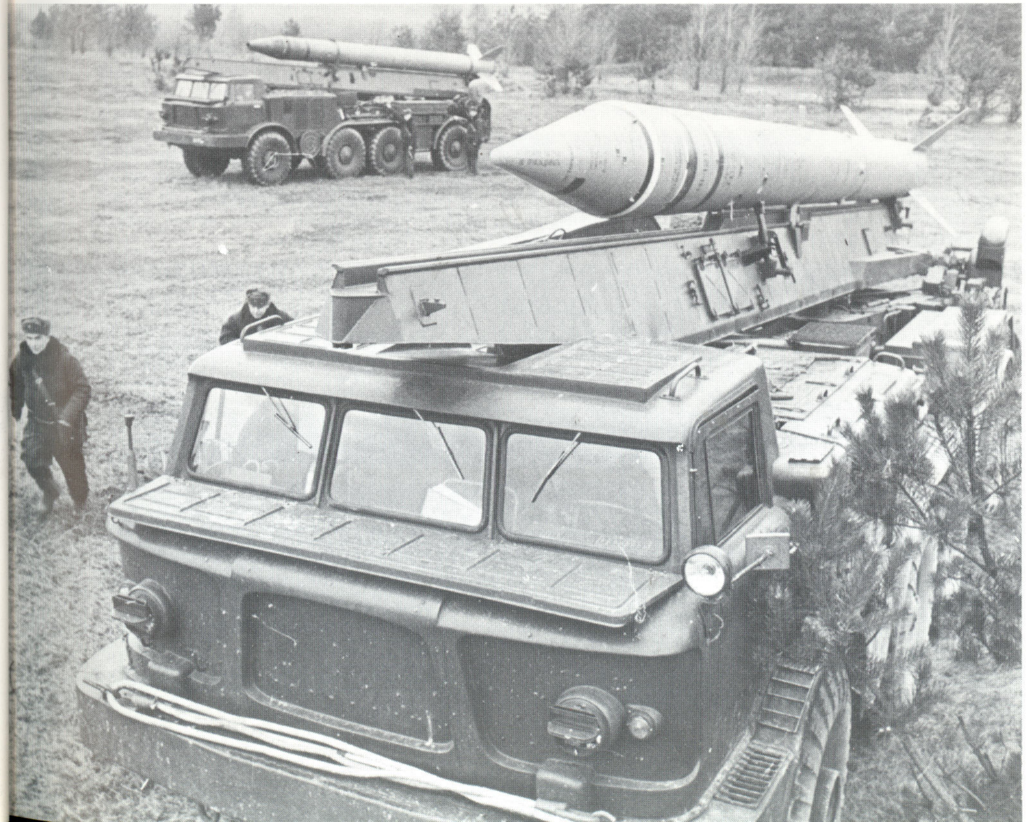
Below: 'Frog-5s' being unloaded from an Antonov An-22 transport aircraft.

Top right: 'Frog-3'.

Right: 'Frog-7'.







USSR

Frog-7

Unguided surface-to-surface bombardment missile. In service.

Powered by: Solid-propellant motor. Eighteen small nozzles around main nozzle
Airframe: Cylindrical casing, with cruciform cropped-delta tail fins. Pointed nose-cone
Guidance and Control: No guidance system. Spin stabilised
Warhead: Alternative nuclear or high-explosive.
Length: approx 29ft 6in (9m)
Body diameter: 1ft 11.6in (0.60m)
Range: approx 37 miles (60km)

Development and Service
'Frog-7' was first seen in Moscow on 7 November 1965. It reverts to the original single-stage configuration. Also, like most of the other battlefield missiles identified since the mid-1960s, it is transported on a wheeled vehicle (Zil 135) rather than the former tracked launcher. Its range can be shortened by use of speed brakes.

'Frog-7s' were deployed rapidly in the Soviet Army and with the armed forces of Russia's friends and allies, including Warsaw Pact nations, Egypt, Iraq, North Korea and Syria. Some photographs have shown the transporter/launcher carrying two additional missiles, to each side of the ready-to-fire 'Frog-7' on the launch-rail.

Israel

Gabriel

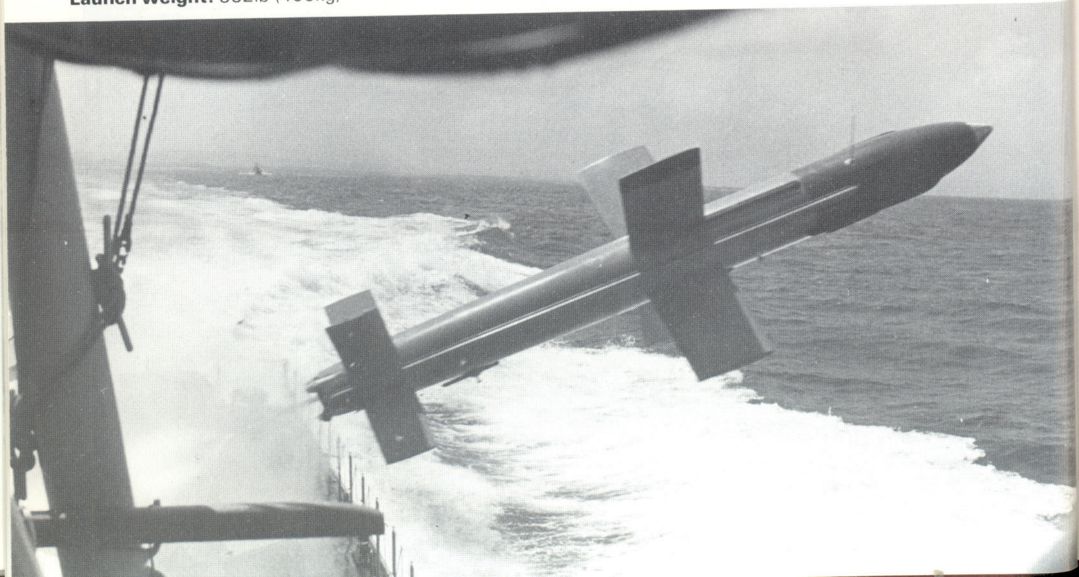
Ship-launched surface-to-surface missile. In production and service.

Data: Gabriel Mk1
Prime contractor: Israel Aircraft Industries Ltd
Powered by: Solid-propellant rocket motor
Airframe: Basically cylindrical body, tapering towards the tail. Rectangular cruciform wings and tail surfaces, indexed in line with each other. Ogival nose-cone
Guidance and Control: Inertial guidance system, with radio altimeter, or manual/optical system, with I-band semi-active radar terminal homing. Control by rear fins
Warhead: High-explosive, weighing 396lb (180kg)
Length: 11ft 0in (3.35m)
Body diameter: 12.8in (0.325m)
Wing span: 4ft 6.5in (1.39m)
Launch weight: 882lb (400kg)
Max speed: Mach 0.7
Range limits: 1.24-13.7 miles (2-22km)

Development and Service
This subsonic ship-to-ship weapon is one of only two missiles of Israeli design of which details have yet been released officially. Gabriel was developed by IAI in collaboration with the Israeli Navy, the obvious purpose being to provide a counter to missile-launching ships like the Egyptian Osa class which sank the Israeli destroyer *Eilat* in 1967. It has been operational since early 1970 on Israel's 12 French-built Saar class gunboats, six of which carry eight launchers each — two three-round swivelling launchers amidships and two single fixed launchers forward — and six with only two three-round launchers each. Fifteen Reshef class fast attack boats, built in Israel, each carry seven Gabriel launchers aft of the superstructure.

Gabriel is delivered inside a glassfibre container which embodies the launching rail and is simply installed on the ship-board mountings without further test or adjustment. It can be launched in bad weather or rough seas, and is said to approach its target only a few metres above the water, lessening the possibility of detection. IAI describe it as an automatic homing weapon and claim that it is impervious to enemy electronic countermeasures. A long-range version of Gabriel was announced in 1972, incorporating modifications in the propulsion and guidance (including a home-on-jam mode) systems. Range is more than 25 miles (41km). This version is also in production and service and both versions have been exported.

A successor to the Gabriel Mk 2 is reported to be under development. It will be a supersonic sea-skimming missile with a longer range than earlier Gabriels and with improved guidance. Surface and air launches may be possible. It could enter service in 1984.



USSR

Gainful (SA-6)

Surface-to-air missile. In service.

Powered by: Integral rocket-ramjet, employing solid propellant for both phases of operation
Airframe: Cylindrical body, with cruciform wings at mid-body, indexed in line with cruciform tail surfaces. Slim cylindrical duct from forward of wing almost to tail on each side of body. Shorter ducts of similar form above and below body. Ducts are air intakes for ramjet phase of flight
Guidance and Control: Radio command; semi-active radar terminal homing
Warhead: High-explosive, weighing 176lb (80kg)
Length: 20ft 4in (6.2m)
Body diameter: 1ft 1.25in (0.335m)
Launch weight: 1,212lb (550kg)
Cruising speed: Mach 2.8
Ceiling: 11 miles (18km)
Slant range: 18.5-37 miles (30-60km)

Development and Service
First displayed in public during a Moscow parade on 7 November 1967, this compact anti-aircraft missile has since become a standard weapon in the Soviet forces and is deployed in Bulgaria, Czechoslovakia, Egypt, Hungary, Iraq, Libya, Mozambique, Poland, Syria and Vietnam. It is somewhat larger than the American Hawk and fulfils a similar role, by providing a rapid-reaction defence against aircraft flying at low and medium altitudes. Three 'Gainful' missiles are carried side-by-side atop a modified PT-76 tracked transporter/launcher.

Missiles of this type were used very effectively by the Arab forces during the October 1973 war with Israel. Captured SA-6s proved to have an integral rocket-ramjet propulsion system of the kind described under the ASALM entry, but using solid propellant in both the rocket and ramjet phases of flight. In the ramjet cruise phase, the exhaust from a solid-propellant gas generator is mixed with air in the combustion chamber and further ignition takes place, greatly increasing mass flow.

ДА ЗДРАВСТВУЕТ БРАТСКАЯ ДРУЖБА И НЕП
ВЕЛИКОЕ ЗАВОЕВАНИЕ ОКТЯБРЯ

Galosh (ABM-1B)

USSR

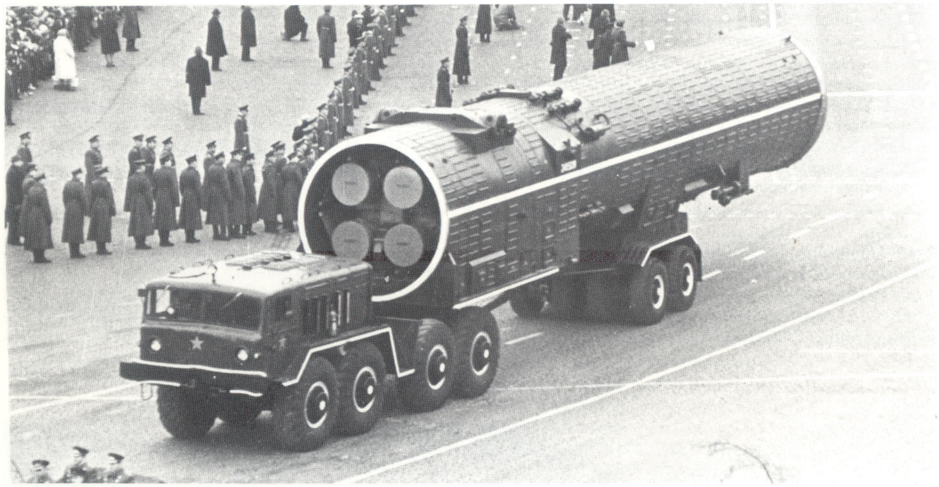
Anti-ballistic missile. In service.

Powered by: Rocket motors with four first-stage nozzles
Guidance and Control: Radar command
Warhead: Nuclear of several megaton yield
Range: over 200 miles (320km)

Development and Service

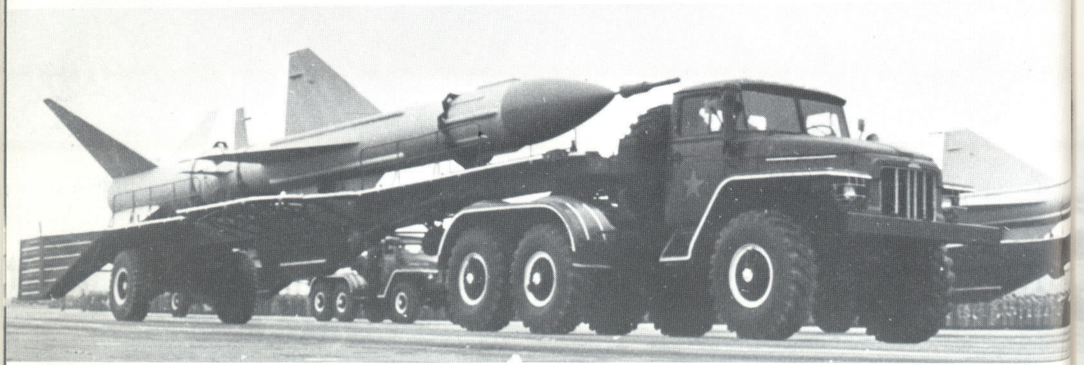
'Galosh' has been under development at least as long as its US counterparts of the Safeguard ABM system. The ribbed cylindrical container in which it is transported (and from which it is, presumably, fired) was first displayed on a tractor/trailer in a Moscow parade on 7 November 1964. On that occasion the Soviet commentator referred to 'Galosh' as an anti-ballistic-missile (ABM) weapon. 'Galosh' is the missile installed in 64 ABM launchers at four sites around Moscow, each with 'Try Add' engagement radars. The early warning radar, known to NATO as 'Hen House', is described as being 'the size of three football fields lined up end-to-end and standing on their sides'. Target acquisition and tracking is by phased-array 'Dog House/Cat House' radars. The radars are being improved.

Very little is known of the 'Galosh' missile itself, except that four first-stage nozzles have been visible inside the container, which is 67ft (20.4m) long with a diameter of 9ft (2.75m). Current ABM development in the Soviet Union is reportedly concentrating on a rapidly deployable system, incorporating improved radars and a new high-altitude missile as good as the projected US Improved Spartan missile, with 'loiter' capability.



Gammon (SA-5)

USSR



Long-range surface-to-air missile. In service.

Powered by: Multi-stage rocket motors. Solid-propellant first-stage booster
Airframe: Cylindrical booster, with large cruciform cropped-delta fins. Smaller-diameter second stage is also cylindrical, with ogival nose; it carries large cropped-delta cruciform wings, each with a control surface inset in its trailing-edge. Cruciform tail control surfaces, on tapering tail of second stage, are indexed in line with wings and at 45 degrees to booster fins. Warhead may separate as third stage and use an in-built rocket motor during final approach to target
Guidance and Control: Radar homing system. Control by wing trailing-edge surfaces and second-stage tail-fins
Warhead: Probably interchangeable nuclear and high-explosive types
Length: 54ft 0in (16.50m) with nose-probe
Body diameter: Booster 3ft 3.5in (1.00m)
2nd stage 2ft 7.5in (0.80m)
Wing span: 13ft 0in (3.96m)
Launch weight: approx 22,050lb (10,000kg)
Max speed: over Mach 3.5
Range: approx 155 miles (250km)
Effective ceiling: 18 miles (29km)

Development and Service

Largest Russian surface-to-air missile yet revealed publicly, 'Gammon' (known originally as 'Griffon') has been trundled through Moscow on a trailer regularly since November 1963. It was then described by the Soviet commentator as an anti-missile missile, but does not appear to have the capability of intercepting an ICBM warhead. Its use is almost certainly limited to an anti-aircraft role, with limited effectiveness against tactical ballistic missiles and air-to-surface weapons.

Ganef (SA-4)

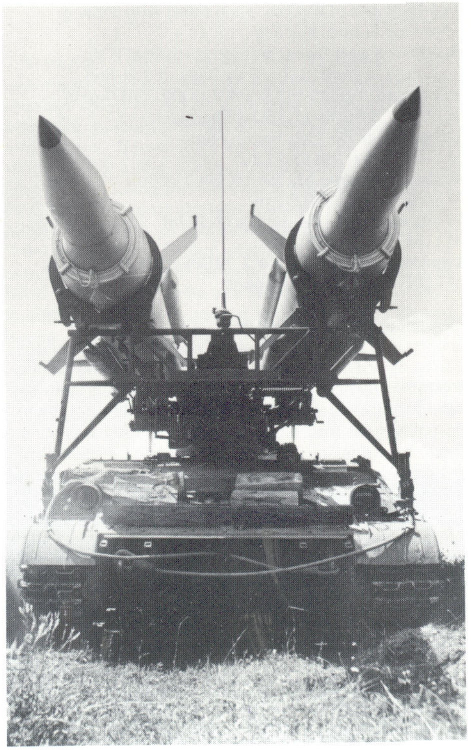
USSR

Surface-to-air missile. In service.

Powered by: Ramjet sustainer. Four solid-propellant wrap-round boosters, with canted nozzles, which jettison after burn-out
Airframe: Cylindrical main body, with smaller-diameter centre-body carrying pointed conical warhead. Cruciform pivoted wings on fore-part of main body, indexed at 45 degrees to fixed cruciform tail-fins. Boosters equi-spaced around body aft of wings
Guidance and Control: Command guidance system, with possible semi-active radar terminal homing. Control via pivoted wings
Warhead: High-explosive
Length: 30ft 0in (9.15m)
Max body diameter: 2ft 8in (0.80m)
Wing span: 7ft 6in (2.30m)
Launch weight: approx 2,200lb (1,000kg)
Ceiling: 80,000ft (24,400m)
Max speed: Mach 2.5
Range: approx 43.5 miles (70km)

Development and Service

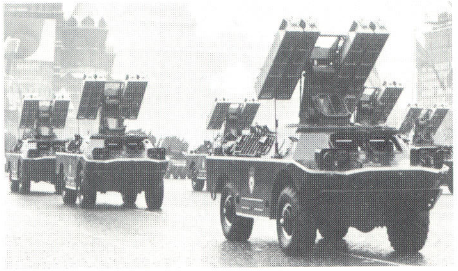
This weapon was probably evolved to provide Soviet land forces with a highly mobile anti-aircraft defence effective up to the service ceiling of most contemporary combat aircraft. It is said to operate in forward areas, about 6 miles (10km) behind the army front line, which can be supported by the use of an armoured launch vehicle. The annular air-intake between the main body and the centre-body suggests the use of a ramjet sustainer engine, which would be consistent with long range. The twin-round tracked launcher carrying 'Ganef' was first shown in a Moscow parade in May 1964. Since then this missile system has been deployed widely in the Soviet Union and serves also in Czechoslovakia and East Germany. 'Ganefs' were also despatched to Egypt, but these are no longer operational. 'Ganef' can be transported on its launch vehicle by aircraft like the An-22 freighter. It may have a surface-to-surface capability.



Gaskin (SA-9)

USSR

This is a mobile surface-to-air weapon system using a tube-launched missile similar to the SA-7 ('Grail') but larger, with a heavier warhead and longer range. Two two-round launchers are mounted on a BRDM-2 armoured amphibious vehicle. It is thought that a new version of 'Gaskin' is currently under development. 'Gaskin' is in service with Warsaw Pact nations, Egypt and, perhaps, Syria.



GBU-8 (HOBOS) and GBU-15

USA

Homing bomb system. In production and service (GBU-8).

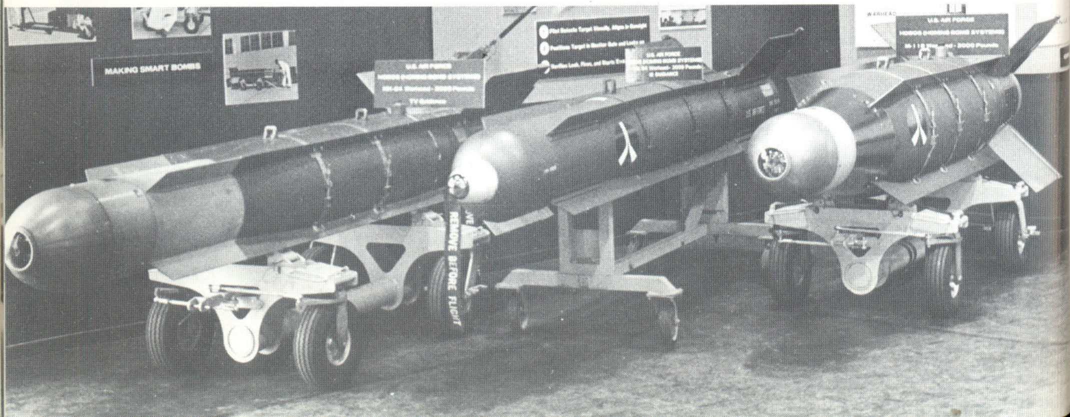
Data: Initial versions of HOBOS
Prime contractor: Missile Systems Division, Rockwell International
Airframe: Cylindrical nose and tail assemblies, linked by four long-chord, short span strakes, fit over standard bomb casing. Cruciform tail-fins integral with rear end of strakes, each fitted with trailing-edge flap control surface
Guidance and Control: Electro-optical (TV) guidance system. Control by flaps on tail-fins
Warhead: Standard Mk 84 2,000lb (907kg) or M118E1 3,000lb (1,360kg) bomb
Length: Mk 84 12ft 5in (3.78m)
M118E1 12ft 2in (3.71m)
Body diameter: Mk 84 1ft 6in (0.46m)
M118E1 2ft 0in (0.61m)
Wing span: Mk 84 3ft 8in (1.12m)
M118E1 4ft 4in (1.32m)
Launch weight: Mk 84 2,240lb (1,016kg)
M118E1 3,404lb (1,544kg)

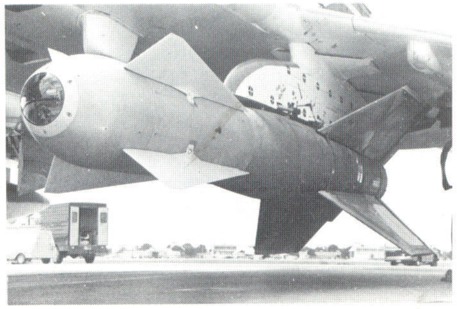
Development and Service

Developed under the USAF's electro-optical guided bomb (EOGB) programme, HOBOS (HOming BOmb System) comprises a kit of parts which can be mounted on standard Mk 84 and M118E1 bombs to convert them into highly-accurate guided weapons. Each kit consists of a forward guidance assembly, the interconnect section (including the bomb) and an aft control section (including an autopilot). Most current production HOBOS missiles are built around Mk 84 bombs and use the TV type of guidance that was developed on the Army Hornet experimental air-to-surface missile. With this, the operator has only to lock the missile's stabilised vidicon camera on to the target before launch, by means of a TV monitor. The missile then homes automatically on the target after launch. The normal bomb suspension and release systems are unchanged.

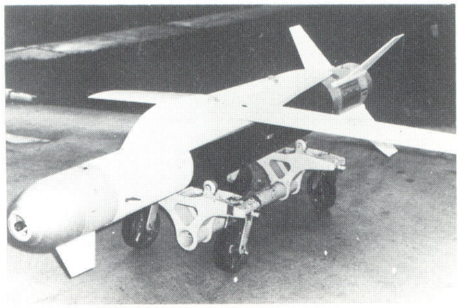
Use of HOBOS in Vietnam, notably against aircraft in revetments, jungle roads and bridges, led to further production for the US services and for foreign customers, including Greece and Israel. Development has also continued, and the USAF designation for the weapon system in its latest form is GBU-15, covering a family of modular glide weapons. To provide day and night all-weather capability, the original TV guidance system can be replaced by imaging infra-red or laser seekers, and a midcourse system that includes distance measuring equipment (DME) for improved accuracy. Alternative warheads can include the GBU-75 cluster munition dispenser. The resulting glide bombs have self-contained guidance and are extremely accurate with long-range stand-off capability. Direct and indirect attack versions are produced by using different interchangeable modular elements. For indirect attack a data link module is used to allow control during flight. The two basic versions of the system are the Planar Wing Weapon (PWW) and the Cruciform Wing Weapon (CWW).

Below: TV-guided HOBOS and infra-red guided HOBOS using Mk 84 bombs (left and centre), and TV-guided HOBOS using M118E1 bomb.





Above: GBU-15 Cruciform Wing Weapon.



Above right: GBU-15 Planar Wing Weapon.

The former uses TV data or DME guidance and has a wing span of 11ft 4in (3.45m): Hughes Aircraft Company is responsible for system integration. During the initial launch of a PWW weapon, on 15 November 1977 (by a Boeing B-52 over the White Sands Missile Range, New Mexico), a 'lethal' hit was made on a simulated power-plant target. The indirect attack version of the CWW began flight tests in February 1975, and more than 50 had been launched by July 1978. This version is expected to be the first in US service.

Gecko (SA-8)

USSR

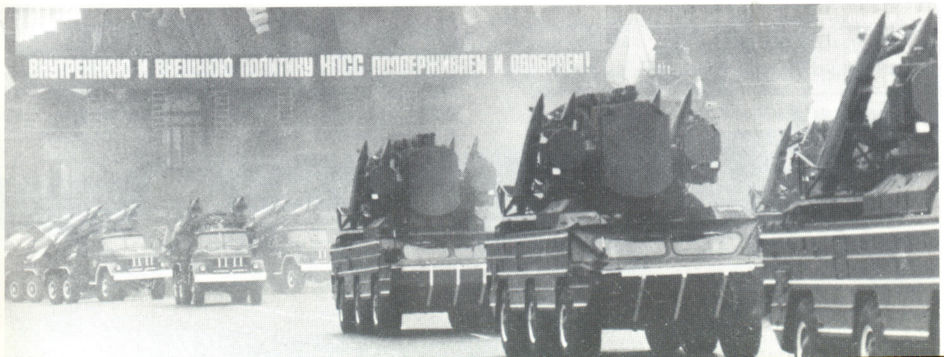
Surface-to-air weapon system. In service.

Powered by: Solid-propellant dual-thrust rocket motor.
Airframe: Cylindrical body with canard control surfaces and fixed tail-fins.
Guidance and Control: Command guidance with infra-red terminal homing. Control by canard surfaces.
Warhead: High-explosive, about 90-110lb (40-50kg) weight with proximity fuse
Length: 10ft 6in (3.2m)
Body diameter: 8.25in (0.21m)
Tail span: 2ft 1in (0.64m)
Max speed: approx Mach 1.5
Ceiling: approx 19,700ft (6,000m)
Range: 5-7.5 miles (8-12km)

Development and Service

Soviet counterpart to Roland, this missile system was first displayed publicly in a Moscow parade on 7 November 1975. Fire-control equipment and quadruple launcher for the short-range all-weather missiles are mounted on a rotating turret, carried by a new three-axle six-wheel vehicle that appears to be amphibious. Surveillance radar, with an estimated range of 18 miles (29km), folds down behind the launcher, enabling the weapon system to be airlifted by Soviet transport aircraft. Tracking radar is of the pulsed type, with an estimated range of 12-15 miles (19-24km). Two 'Gecko' missiles can be launched simultaneously at the same or separate targets. The SA-8 was thought to be at a service evaluation stage in early 1976, and is now in service with the Soviet forces. The same missile is thought to be used in the naval SA-N-4 system.

Below: 'Gecko' launch vehicles in Moscow parade, November 1977.



Genie (AIR-2A)

USA

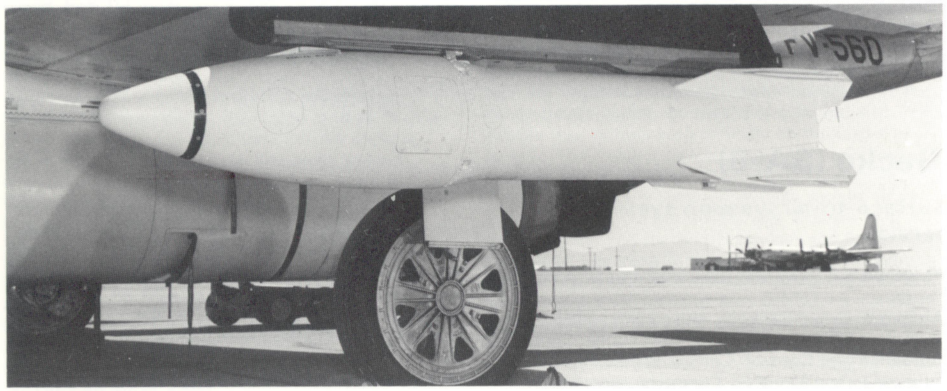
Unguided air-to-air nuclear missile. In service.

Prime contractor: McDonnell Douglas Astronautics Company
Powered by: Thiokol SR49-TC-1 solid-propellant rocket motor of 36,000lb (16,330kg) st
Airframe: Cylindrical body with cruciform tail-fins, each with movable tip, and an ogival nose of greater basic diameter than body
Guidance and Control: No guidance system
Warhead: Nuclear, with yield reported as 1.5 kilotons
Length: 9ft 7in (2.91m)
Body diameter: 1ft 5.35in (0.44m)
Fin span: 3ft 3.5in (1.00m)
Launch weight: 820lb (372kg)
Max speed: Mach 3
Max range: 6 miles (9.6km)

Development and Service

Although Genie is an unguided rocket, it justifies inclusion in this book by reason of its nuclear warhead. It was the first nuclear-tipped air-to-air missile ever tested in a live firing when, on 19 July 1957, it was launched from a Northrop F-89J Scorpion at Indian Springs, Nevada. Immediately after launch, at a height of 15,000ft, the pilot of the fighter turned sharply to escape the blast and the missile was detonated from the ground after travelling three miles (4.8km). USAF observers who stood directly under the point of detonation for an hour suffered no ill effects.

Several thousand Genies were delivered, many of which continue in first line service with F-106 squadrons of the USAF and CF-101F squadrons of the Canadian Armed Forces, the only nuclear weapons now in Canadian service. They are designed to be fired automatically and detonated by the Hughes fire-control system fitted in each aircraft. A training version, without nuclear warhead, is also in service.



Goa (SA-3/SA-N-1)

USSR

Surface-to-air close-range missile. In service.

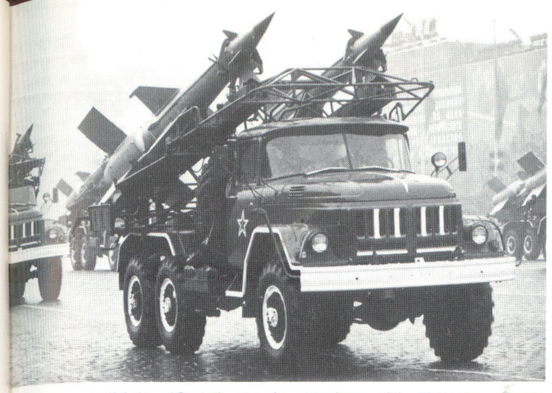
Powered by: Two-stage solid-propellant rocket motors
Airframe: Two basically cylindrical stages, in tandem. Booster fitted with large rectangular cruciform fins. Second stage has cruciform fixed wings at rear and cruciform cropped-delta control surfaces on the tapered nose-cone
Guidance and Control: Radio command with radar terminal homing. Control by movable foreplanes
Warhead: High-explosive
Length: 22ft (6.7m)
Body diameter: Booster 2ft 0in (0.60m)
Second stage 1ft 6in (0.45m)
Wing span: 4ft 0in (1.22m)
Ceiling: 40,000ft (12,200m)
Max speed: Mach 2
Range: over 18.5 miles (30km)

Development and Service

Russia's 1961 counterpart to the American Hawk, 'Goa' is the anti-aircraft missile which caused much concern to the Israeli Air Force when 14 batteries supplemented earlier 'Guidelines' near the Suez Canal ten years later. It is effective over a slant range of more than 18.5 miles (30km) to a height of over 40,000ft (12,200m), and is known in America as the SA-3 or SAM-3 in its land-based version. Its compact form is evident from the fact that pairs of 'Goas' can be transported on the Zil 157 truck that is used as a tractor for the 'Guideline' and 'Guild' trailer-transporters and has been carried on a tracked vehicle. 'Goas' are in service with Warsaw Pact countries, Egypt, India, Iraq, Libya, Peru, Syria, Vietnam, Uganda and Yugoslavia.

In its ship-based form (SA-N-1) 'Goa' is standard armament in the Soviet Navy, on a twin-round launcher very like that used for the American Tartar missile. Four cruisers of the Kresta I class and 19 destroyers of the Kashin class each carry two launchers, fore and aft. Four cruisers of the Kynda class have a single twin-launcher on their fore-deck; eight destroyers of the Kanin class and eight of the Kotlin class have a similar launcher on their after deck.

A photograph of a twin-launcher on a destroyer, issued by *Tass* in 1971, showed missiles of the 'Goa' type with an additional set of small tail-fins between the booster and second-stage wings. The wings also appear to carry trailing-edge control surfaces.



Above left: 'Goa'.

Above: Soviet Kashin class destroyer with 'Goa' missiles fore and aft.

Goblet (SA-N-3)

USSR

Surface-to-air missile. In service.

Slant range: approx 37 miles (60km)

Development and Service

Little is known about this missile. It arms the helicopter carriers *Leningrad* and *Moskva*, the aircraft carriers *Kiev* and *Minsk*, five Kara and 11 Kresta-II missile cruisers. The fire control radar system is known by the NATO designation 'Head Light'. It has been suggested that 'Goblet' is related to the land-based 'Gainful'.

Grail (SA-7)

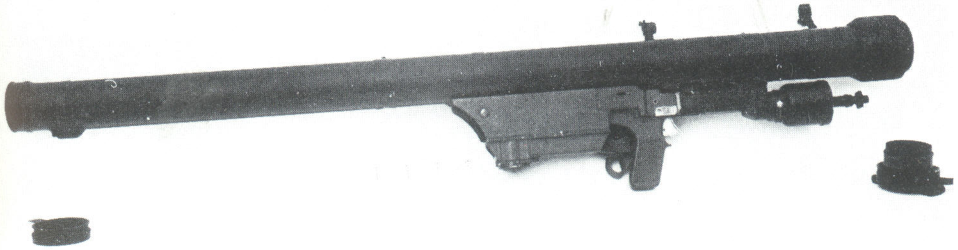
USSR

Shoulder-fired surface-to-air missile. In service.

Guidance and Control: Initial optical aiming, with infra-red terminal homing. Control by foreplanes
Warhead: High-explosive, weighing 5.5lb (2.5kg)
Length: 4ft 5in (1.35m)
Body diameter: approx 2.75in (7cm)
Launch weight: approx 21lb (9.5kg)
Max speed: Mach 1.5
Range: 11,500ft (3,500m)
Operating height limits: 165-5,000ft (50-1,500m)

Development and Service

In the later stages of the Vietnam war the North Vietnamese started using a man-portable, shoulder-fired, anti-aircraft missile that was manufactured in Russia. The same missile system was used widely by Arab forces during the October 1973 war with Israel, and captured examples proved to be similar in principle to the US Redeye. 'Grail' is a tail pursuit weapon, which has proved successful against low-flying helicopters and subsonic fixed-wing aircraft. An improved Mk 2 version has also been built in which the launch tube and equipment differs considerably from that of the earlier 'Grail', and is



said to incorporate an IFF system. Operational altitude could be tripled. SA-7s are in service with Warsaw Pact countries, Angola, Cuba, Egypt, Ethiopia, Iraq, Libya, Kuwait, North Korea, Mozambique, Peru, Syria, Vietnam, South Yemen and Yugoslavia. A naval version of 'Grail' (SA-N-7) has also entered service and arms Osa class missile boats, Shershen class fast attack torpedo boats and other boats including 60 Polnochniy class landing craft, of the Soviet Navy, and a few Egyptian boats. (See also 'Gaskin'.)

GSRS

USA

Surface-to-surface unguided rocket. Under development

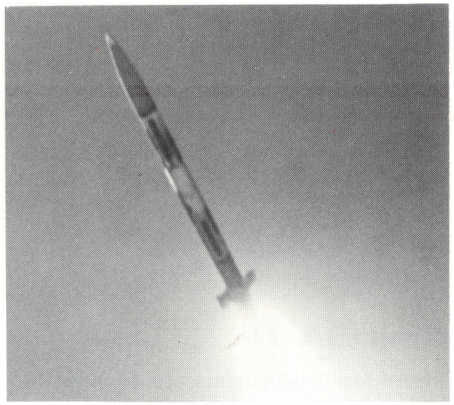
Warhead: M42 anti-tank submunitions, AT-2 mine or terminal homing mine, or smoke
Range: 18.6 miles (30km)

Development and Service

The General Support Rocket System has been conceived as a weapon for deployment in Europe where Warsaw Pact nations have a far greater artillery force than NATO countries. The GSRS is designed to overcome this lack of firepower and will be centred around a 13ft (4m) long and 9in (0.227m) diameter unguided rocket with interchangeable warhead. Two six-round pallets will be carried inside a hydraulically-jacked launch container onboard the XM-723 Infantry Fighting Vehicle. Main targets for the GSRS will be armoured vehicle concentrations, anti-aircraft missile sites and artillery forces.

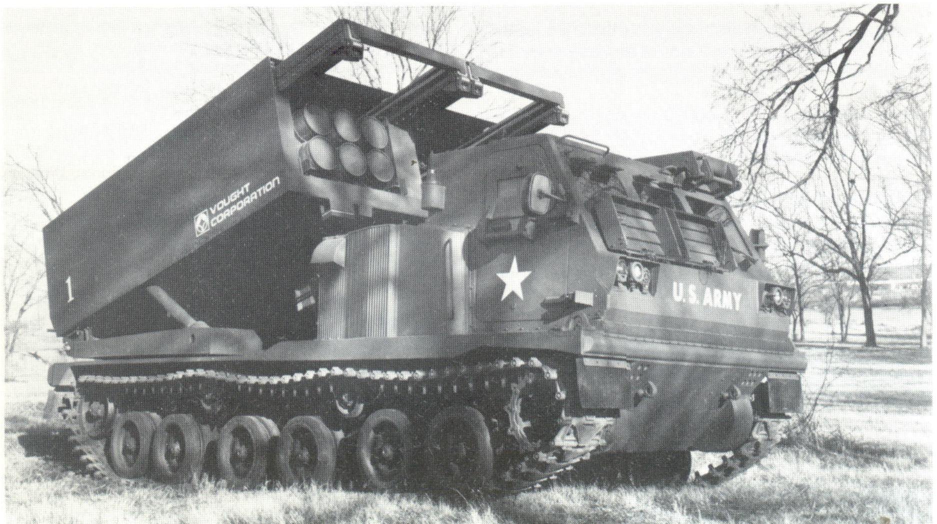
In 1976 the US began a feasibility study of the GSRS. Its main advantages over other systems are its high rate of fire and low unit cost of the rockets. Vought and Boeing were awarded competitive contracts in 1977 to begin development of GSRS systems, following concept definition studies by four US companies, and a declaration of cooperation was signed by the USA, UK and Germany to share in the design and eventual production of the system the same year. Vought and Boeing were expected to enter a competitive 'shoot off' to their systems at White Sands Missile Range in late 1979.

Short range firings of the Vought GSRS took place in October 1977, followed in November by warhead ground tests, the first GSRS demonstration rocket firing on 5 December and first multiple launch on 19 December. The first rocket launch from a tactical container was made in April 1978. Following a certain amount of redesign, the first launch of a revised rocket and first three rocket launch from a common launch pod took place on 1 December and 13 December 1978 respectively. When production eventually gets underway, more than 5,000 GSRS rockets will be built every month.



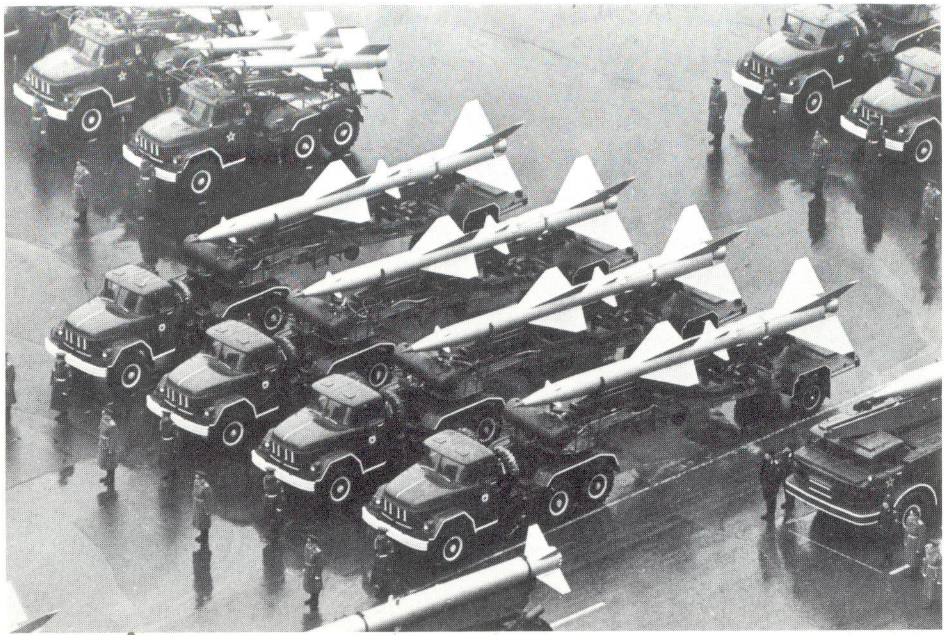
Right: First launch of a GSRS from a tactical container.

Below: GSRS self-propelled launcher/loader undergoing tests.



Guideline (V750VK) (SA-2/SA-N-2)

USSR



Above: 'Guideline Mk 2s' photographed during the 1977 Moscow parade.

Surface-to-air missile. In service.

Data: 'Mk 2' version
Powered by: Liquid-propellant sustainer; solid-propellant booster
Airframe: Tandem two-stage missile. Booster is cylindrical with cruciform cropped-delta fins, two of which have trailing-edge control surfaces. Smaller-diameter second stage has cylindrical body with flared skirt, fixed cruciform wings about mid-way between nose and tail, and small cruciform tail control surfaces, all indexed in line with booster fins. Small cruciform vanes on nose
Guidance and Control: Automatic radio command. Control by movable tail surfaces and control surfaces on booster fins
Warhead: High-explosive, weighing 288lb (131kg) with contact or proximity fuse, or detonated by command (see below)
Length: 35ft 1.5in (10.70m)
Body diameter: Booster 2ft 3.5in (0.70m)
Second stage 1ft 8in (0.50m)
Wing span: 5ft 7in (1.70m)
Launch weight: approx 5,070lb (2,300kg)
Max speed: Mach 3.5
Slant range: approx 25-31 miles (40-45km)
Effective ceiling: over 11.2 miles (18km)

Development and Service

Most widely used of all Soviet anti-aircraft missiles, 'Guideline' was first displayed in Moscow in 1957. It serves in the Soviet Union and the Warsaw Pact countries, and has been supplied in vast numbers to Afghanistan, Algeria, China (also locally built), Cuba, Egypt, India, Iraq, Libya, Mongolia, North Korea, Syria, Vietnam and Yugoslavia. The number deployed in the Soviet Union is gradually declining as greater numbers of 'Goa' and 'Gammon' missiles became operational.

'Guidelines' captured by Israeli forces during the 1967 war were said to bear the Soviet designation V750VK, with the designation V75SM applicable to the entire weapon system. This includes a Zil 157 semi-trailer transporter-erector vehicle or new type transporter, radar van and generators. The US designation is SA-2, or SAM-2; while the version carried on a twin-launcher by the Soviet Navy cruiser *Dzerzhinski* is known as SA-N-2. 'Guideline' has undergone considerable development. The original version, which might be referred to for convenience as the 'Mk1', was similar to the first-generation US Nike Ajax in many design features and probably had a comparable performance. Initially the nose vanes were rectangular, but the 'Mk 2' version captured by the Israelis had cropped-delta vanes. The latest 'Mk 4' version, first displayed in Moscow in 1967, is about 15in (40cm) longer than the 'Mk 2', and lacks the latter's nose vanes and booster control surfaces. It was described by the Soviet commentator as being far more effective than earlier versions, which may imply use of a nuclear warhead in the bulged, white-painted nose-cone.

Guild (SA-1)

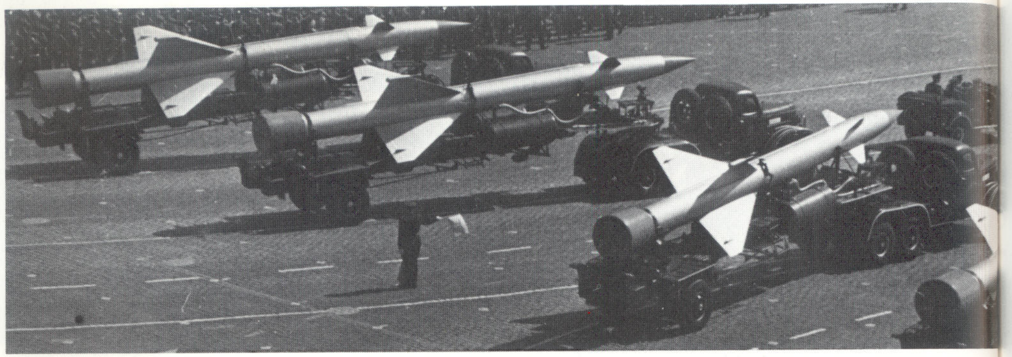
USSR

Surface-to-air missile. In service.

Powered by: Liquid-propellant rocket motor
Airframe: Cylindrical body, with pointed ogival nose. Cruciform cropped-delta wings, each with trailing-edge control surface. Cruciform foreplane control surfaces indexed in line with wings
Guidance and Control: Control by foreplanes and wing trailing-edge surfaces
Warhead: High-explosive
Length: 39ft 0in (12.0m)
Body diameter: approx 2ft 3.5in (0.70m)
Range: approx 20 miles (32km)

Development and Service

'Guild' was the second type of Soviet surface-to-air missile displayed in a Moscow parade, on 7 November 1960. Unlike 'Guideline' it has no separate booster. Although 'Guild' has been a standard defensive weapon in the USSR since 1954, there is no evidence to suggest that it has been exported. Continued deployment must be doubtful as the missile is obsolete.



HARM (AGM-88A)

USA

High-speed air-to-surface anti-radar missile. Under development.

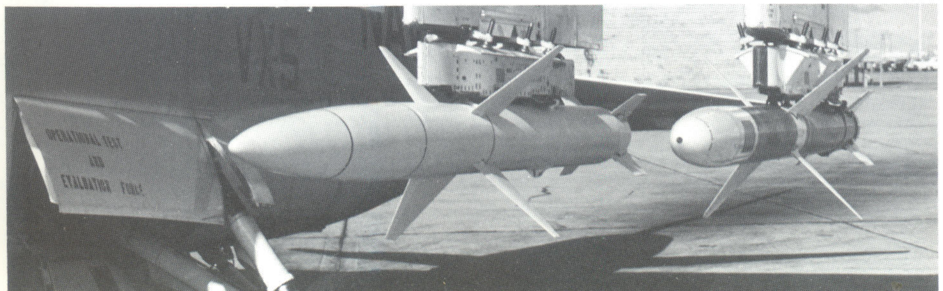
Prime contractor: Texas Instruments Inc
Powered by: Thiokol solid-propellant rocket motor
Airframe: Cylindrical body with ogival nose. Cruciform double-delta wings indexed in line with cruciform tail fins
Length: 13ft 8in (4.17m)
Body diameter: 10in (0.254m)
Wing span: 3ft 8.5in (1.13m)
Launch weight: 780lb (354kg)
Range: over 10 miles (16km)

Development and Service

Little information on this new missile is yet available. Its development was prompted by experience in Vietnam, where Soviet-built radars were often able to detect oncoming first-generation anti-radiation weapons such as Shrike and shut down before the missile could home on their emissions. HARM (High-speed Anti-Radiation Missile) is intended to have such a high performance that it would home on any radar before the operators had time to switch off. It can also cover a wide frequency range, thus enabling use against different types of radar.

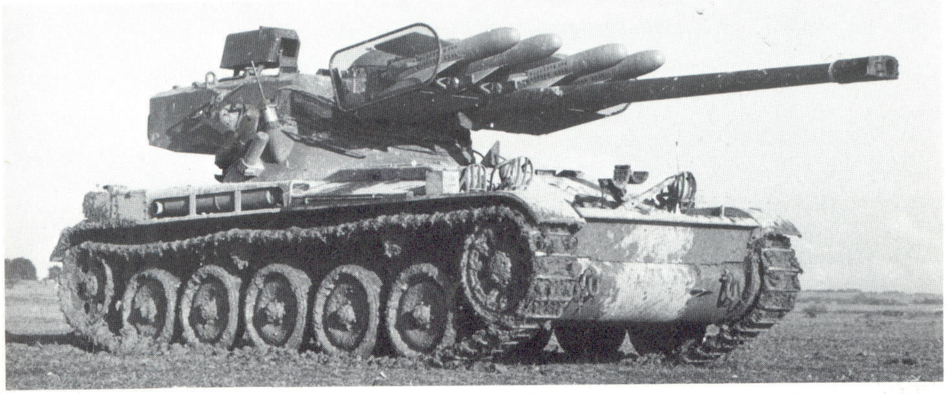
Texas Instruments was named prime contractor for HARM in May 1974. Nine advanced development missiles were built initially and successfully fired during 1975 and 1976. By 1978, HARM missiles had been launched from F-4 Phantom II, Intruder and Corsair II naval aircraft. It will also subsequently arm USAF F-4G 'Wild Weasel' Phantoms and could arm the EA-6 Prowler and F-18. Engineering development was scheduled to continue through 1979. It is anticipated that about 5,000 HARM missiles will be purchased.

Below: HARM missile (left) under the wing of a Corsair II.



Harpon

France



Above: Harpon missile on an AMX-13 tank.

Anti-tank missile. In service.

Prime contractor: Nord-Aviation/Aérospatiale, Division Engins Tactiques
Powered by: Two stage solid-propellant rocket motor
Guidance and Control: Wire-guidance, using TCA optical aiming/infra-red tracking system. Control by varying sustainer efflux thrust
Length: 3ft 11.75in (1.21m)
Body diameter: 6.5in (0.164m)
Wing span: 1ft 7.5in (0.50m)
Launch weight: 67lb (30.4kg)
Max range: 9,840ft (3,000m)

Development and Service

Harpon is externally similar to the SS.11 B.1 anti-tank missile, with similar performance and alternative warheads, but utilises the TCA type of automatic guidance described under the AS.30 entry. It was, in fact, the first of a long series of weapons which Nord-Aviation (now Aérospatiale) adapted or designed to use this guidance system. Harpon has proved able to operate effectively over ranges as small as 1,200ft (400m) as no time is lost by the operator having to acquire the missile after launch. It is normally deployed on a launcher turret carried by light armoured vehicles, and is claimed to offer a defence against head-on attack by low-flying fixed-wing aircraft or helicopters in a surface-to-air role. Harpon is operated by France, West Germany and Saudi Arabia, although HOT missiles are generally replacing Harpons.

Harpoon (AGM-84A and RGM-84A-1)

USA

Air-to-surface, surface-to-surface and subsurface-to-surface anti-shipping missile. In production and service

Prime contractor: McDonnell Douglas Astronautics Company-East
Powered by: Teledyne CAE J402-CA-400 turbojet engine, rated at 660lb (299kg)st Aerojet solid-propellant booster for surface-to-surface and subsurface launch only
Airframe: Cylindrical body, with ogival nose. Cruciform wings and cruciform tail surfaces, indexed in line, and foldable for some launch platforms. Flush air intake for turbojet. When tandem booster is fitted, its cruciform fins are indexed in line with missile fins.
Guidance and Control: Terminal guidance by Texas Instruments active radar seeker. Midcourse guidance unit by IBM, consisting of a digital computer and strapdown attitude reference system. Altitude monitored by a Honeywell radar altimeter. Control by tail surfaces, each powered by electromechanical actuator
Warhead: High-explosive blast type, weighing 500lb (225kg)
Length: AGM-84A 12ft 7in (3.84m)
RGM-84A-1 15ft 0in (4.57m)
Body diameter: 1ft 1.5in (0.34m)
Wing span: 3ft 0in (0.91m)
Launch weight: AGM-84A 1,150lb (521kg)
RGM-84A-1 1,470lb (667kg)
Cruising speed: High subsonic
Range: 80 miles (50km)

Development and Service

After three years of research and study, and evaluation of competing tenders from five major US aerospace companies, McDonnell Douglas was named prime contractor for this important all-weather anti-ship weapon in June 1971. Harpoon has since been developed under the direction of the

Top: Harpoon launch.

Above: Air-launched Harpoons, without first-stage boosters, carried by an Intruder.

US Navy's Naval Air Systems Command, and by mid-1974 Harpoons had been launched from ships, P-3 Orion aircraft, hydrofoil patrol boats and submarines. Pilot production go-ahead by the Navy was authorised in July 1974. Operational evaluation and test were completed in July 1977. Harpoon is compatible with Asroc, Tartar and Mark 26 launchers, as well as different types of aircraft. A data processor common to all launcher systems provides all targeting data to the missile, and no inputs from the platform are required after launch. In a typical air launch, the AGM-84A Harpoon descends in a programmed dive until pullout is commanded by the radar altimeter. The missile then levels out and flies to the target at a wave-skimming altitude. In the last few seconds before impact, it pitches up and dives at the target to avoid close-in defences and to enhance warhead effectiveness. For ship launch, the booster-assisted RGM-84A-1 missile is launched from existing launcher platforms at a low elevation angle and follows a ballistic trajectory until booster separation. The sustainer engine is then started and the missile descends to cruise altitude, following the same trajectory as that for air launch. A canister launcher is used to adapt Harpoon to surface ships where standard types of launchers are not available. The canister serves as a shipping container and provides a protective environment in operational use.

The submarine-launched configuration is the same as for the canister launcher, except that the missile is installed in a buoyant capsule. After exiting the torpedo tube, the capsule rises to the surface, using control fins to maintain the required altitude. Upon broach, the capsule ends are jettisoned and the Harpoon booster ignites, propelling the missile out of the capsule and into the same trajectory as that used in surface launches. All versions are fitted with counter-countermeasures devices.

The US Navy currently expects to install Harpoon weapon systems on all its guided missile cruisers and destroyers, Spruance class destroyers, Oliver Hazard Perry class guided missile and Knox class frigates, missile-armed patrol hydrofoils, nuclear attack submarines, and Orion, Intruder and Viking aircraft, totalling about 1,300 units. Twelve other countries have ordered Harpoon systems, and the capsule and electronics for the submarine-launched configuration for the Royal Navy and others are being manufactured under licence in the UK by Lucas Aerospace. Production of Harpoon will continue until 1986.

Hawk (MIM-23A) and Improved Hawk (MIM-23B) USA

Surface-to-air close-range missile. In production and service.

Data: Improved Hawk
Prime contractor: Raytheon Company
Powered by: Aerojet XM112 dual-thrust solid-propellant motor
Airframe: Cylindrical metal body with pointed ogival nose. Long-chord cruciform wings, each with trailing-edge elevon
Guidance and Control: Continuous-wave semi-active radar homing system by Raytheon. Control via elevons
Warhead: High-explosive
Length: 16ft 8in (5.08m)
Body diameter: 1ft 2.5in (0.37m)
Wing span: 3ft 11.4in (1.20m)
Launch weight: 1,378lb (625kg)
Max speed: Mach 2.5
Max range: 25 miles (40km)
Ceiling: over 59,000ft (18,000m)

Development and Service

Manufactured in thousands, in Europe and Japan as well as by Raytheon in America, Hawk (Homing-All-the-Way Killer) is the low/medium-altitude anti-aircraft weapon which set the pace in this difficult role. As early as January 1960 a Hawk intercepted and destroyed an Honest John supersonic artillery rocket, so becoming the first missile to bring down a ballistic missile. Later, Hawks achieved equal successes against a smaller Littlejohn and Corporal guided ballistic missile. They became operational in August 1960 and were subsequently deployed by the US Army and Marine Corps in Europe, Korea, Okinawa, the Panama Canal Zone and Vietnam. Other nations that received Hawks included Belgium, France, Israel, Italy, Japan, Netherlands, Saudi Arabia, South Korea, Spain, Sweden, Taiwan, Thailand and West Germany.

The complete Hawk weapon system is transportable by fixed-wing aircraft and helicopters. A typical battery consists of six three-round launchers, a tracked loader which collects three missiles at a time for delivery to the launchers, a pulse acquisition radar, a CW acquisition radar, a range-only radar, two target illumination radars and a battery control centre. The original trailer-type launcher was replaced in some US Army units by a self-propelled launcher based on an M727 tracked vehicle able to tow an item of ground support equipment. A platoon has three vehicles. The effectiveness of Hawk, down to treetop level, results from the fact that its radars can pick out reflected signals from a moving target at low altitude from the mass of signals reflected by objects on the ground. When, in certain operations, it is necessary to bring the missiles into action quickly, and with a minimum of equipment, an assault fire command console can be used. This lightweight unit has been developed to permit firing with the addition of only a single launcher, illuminator, generator, loader and pallet, and missiles.

In 1964, Raytheon began development of Improved Hawk, a completely redesigned missile with solid-state guidance package, larger warhead and improved Aerojet propulsion system using an upgraded and higher-impulse polyurethane propellant. Ground support equipment has also been updated in this system which has better ECM protection. Improved Hawk is in full production and is deployed with or has been ordered by the US Army and Marine Corps, Denmark, France, Greece, Iran, Italy, South Korea, Kuwait, Netherlands, Saudi Arabia, Spain, Sweden, Taiwan and West Germany.

A new self-propelled version of Improved Hawk has also been built, based on the Lockheed eight-wheel Dragon-Wagon all terrain vehicle. This system allows greater mobility and so can react rapidly to changing situations, thus increasing its usefulness and survival probability. Interest in the system has been expressed by several countries.

Below: Improved Hawk missiles being loaded on a launcher.

Hellfire

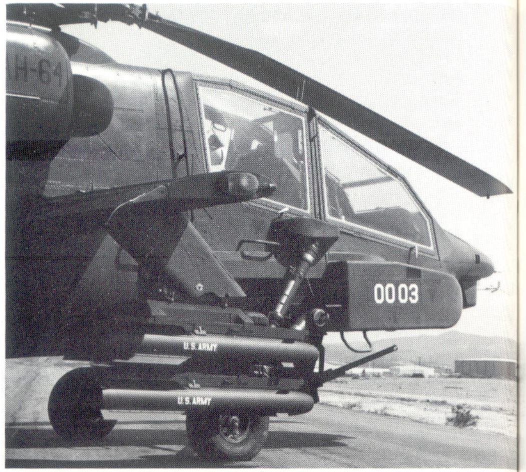
USA

Air-to-surface missile. Under development

Contractor: Missile Systems Division, Rockwell International
Guidance and Control: Semi-active laser homing guidance. Control by wing flaps or movable vanes, depending on missile
Launch weight: Expected to be about 90lb (41kg)

Development and Service
Hellfire is under development as a helicopter-launched modular missile for attacking armoured vehicles and suppression of air defence sites. It will be carried by the AH-64 advanced attack helicopter. The missile will be potentially capable of carrying any one of three seeker heads, but the initial version will use laser homing guidance. Tests have been carried out, using modified Rockwell International Hornet missile airframes and Rockwell laser seekers, at the Army Missile Command, Redstone Arsenal, Alabama.

Hughes Aircraft and Rockwell International were awarded competitive initial contracts, under which each was to build prototype missiles, a launcher, cockpit mockup and other equipment for evaluation. Rockwell International was selected as prime contractor and awarded a follow-on engineering development contract in 1976. Further development plans cover competitive development of additional seekers to provide a true fire-and-forget and air defence suppression capabilities.



Above: Hellfire missiles on a Hughes YAH-64 helicopter.

Honest John (MGR-1)

USA

Surface-to-surface unguided artillery missile. In service.

Data: MGR-1B
Prime contractor: US Army Missile Command (USAMICOM)
Powered by: Hercules M-31A1 single-stage solid-propellant rocket motor
Airframe: Cylindrical metal body, with bulged ogival nose-cone and four clipped-delta tail-fins.
Guidance and Control: Spin stabilisation only; initial spin imparted by Thiokol rockets aft of warhead and maintained throughout flight by canted tail-fins.
Warhead: Alternative nuclear or high-explosive, weighing about 1,500lb (680kg)
Length: 24ft 9.5in (7.55m)
Body diameter: 2ft 6in (0.76m)
Fin span: 4ft 6in (1.37m)
Launch weight: 4,719lb (2,140kg)
Max speed: Mach 1.5
Range limits: 4.6-23 miles (7.4-37km).

Development and Service
Although unguided, this big artillery rocket has provided powerful nuclear support for NATO and Allied armies for well over two decades. Its development was undertaken by Douglas, under the technical supervision of the US Army's Ordnance Missile Laboratories at Redstone Arsenal, Alabama. Firing tests began in 1951, only one year after receipt of the initial contract, and the original MGR-1A version of Honest John was manufactured subsequently in very large numbers by both Douglas and Emerson Electric.

Continued development led to the MGR-1B, reduced in length by about 2ft 5.5in (0.76m) but with improved performance. This version entered first-line service in 1960 and was deployed by US Army units in Europe and Japan, as well as by other countries such as Britain, Belgium, Denmark, France, Greece, the Netherlands, South Korea, Turkey and West Germany. The US Marine Corps formed three Honest John batteries, but disbanded them when the weapon system proved too cumbersome for amphibious operations. Several NATO nations still operate Honest John, although it has been or is being generally replaced by Lance.

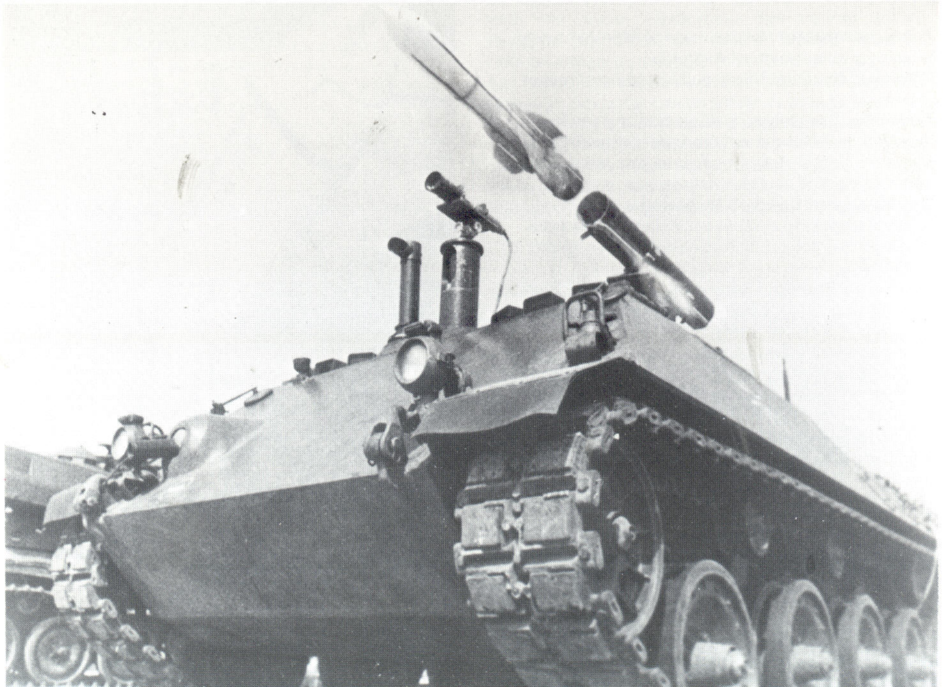
HOT

France/Germany

Anti-tank missile. In production and service.

Prime contractor: Euromissile (Aérospatiale, Division Engins Tactiques/Messerschmitt-Bölkow-Blohm GmbH)
Powered by: Two-stage solid-propellant rocket motor
Airframe: Basically cylindrical body, with aft section of increased diameter and bulged ogival nose. Four flip-out fins
Guidance and Control: Wire guidance, using TCA optical aiming/infra-red tracking system. Spin-stabilised by fins. Control by vanes in rocket exhaust

Below: HOT launch from a Casemate vehicle.



Above: HOT launch from an Alouette III helicopter.

Warhead: Hollow charge weighing 13.2lb (6kg)
Length: 4ft 2.5in (1.27m)
Body diameter: 5.75in (14.3cm)
Fin span: 1ft 0.25in (0.31m)
Launch weight: 52lb (23.5kg)
Max speed: 560mph (900km/h)
Range limits: 250-13,100ft (75-4,000m)

Development and Service

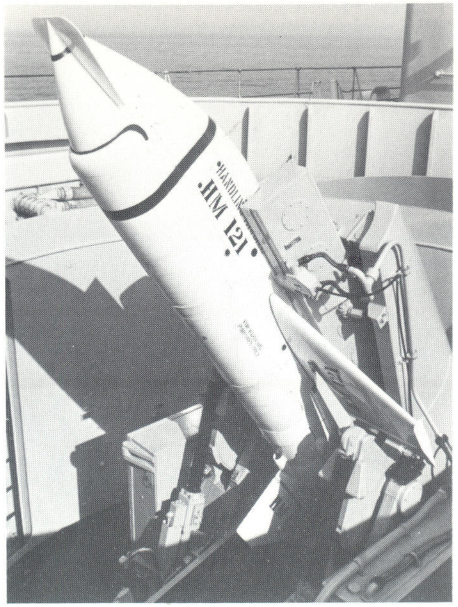
HOT (High-subsonic Optically-guided Tube-launched) is similar in configuration to MILAN and uses the same kind of guidance system, but is larger and has a higher performance. It is intended to be mounted on light armoured vehicles and helicopters, or to be installed for fortification defence. During demonstration firings in 1970, two HOTs from a French AMX-13 tank impacted within 12in (30cm) of the centre of a target over a range of 11,480ft (3,500m). Others were fired over a similar range, during 1971-72, from an Alouette III helicopter; in 1973-74 from an SA 341 Gazelle helicopter, in conjunction with a stabilised sight; and in 1974 from an MBB BO105 helicopter. Series production was initiated in 1976, including an air-to-surface installation for Gazelles of the French Army, and another for BO105s of the German Army, which were first delivered in 1977. Trials on Lynx and Dauphin helicopters took place in 1978. Several other countries have ordered HOT missiles. HOT, like MILAN is claimed to have potential in a surface-to-air role, against head-on attack by helicopters and low-flying fixed-wing aircraft. Its flight time to target is 17 seconds over 4,000m, compared with 21 seconds of propelled flight over 3,000m of the AS.11 which it supersedes. It is also claimed to have a 90% hit probability.

Ikara

Australia

Long-range anti-submarine missile. In service.

Prime contractor: Department of Manufacturing Industry, Government of Australia
Powered by: Dual-thrust solid-propellant rocket motor
Airframe: Basically square-section body, with detachable mid-mounted cropped-delta wings, elevon control surfaces and upper and lower tail-fins. Torpedo cradled in underbody recess
Guidance and Control: Radio/radar guidance/tracking system, receiving signals from automatic target-prediction equipment on board launch-ship. Control via elevons
Warhead: American Type 44 lightweight acoustical homing torpedo, or other types of torpedo
Length: 11ft 0in (3.43m)
Wing span: 5ft 0in (1.53m)
Max speed: Subsonic
Range: up to 11 miles (18km)



Right: Ikara inside its launch bin on a ship.

Development and Service

This long-range anti-submarine missile was designed originally to provide navies with a rapid-reaction weapon which would guarantee a high degree of accuracy under all weather conditions. The Australian Navy has three destroyers of the Perth class each fitted with two single-round launchers, and six River class destroyers each with one launcher. A version known as RN Ikara has been developed jointly by the Australian Department of Manufacturing Industry and Hawker Siddeley Dynamics of the UK for the Royal Navy. This system has been installed in HMS *Bristol* and in eight Leander class frigates. It uses a Vickers-designed missile handling and launch system with Australian-supplied tracking and guidance systems.

Another variant of the system, known as Branik, was manufactured in Australia to arm four Niteroi class destroyers of the Brazilian Navy.

Ikara missiles are stowed in the shipboard magazine as torpedo-fitted bodies, less the detached wings and tail fins. The missile launcher loading process involves automatic selection and conveyance of the body unit to a safety assembly area. Naval ratings quickly fit the wings and fins. Following movement of the loading staff to a safety area, the complete missile is automatically transferred into the rotatable tilting launcher in the firing area. When a potential target is detected by the launch ship's sonar, or through helicopter or other ships' sonars, the launcher is swivelled to an optimum aiming direction. The launching ship's computer and guidance control system establish an optimum missile flight path profile and the missile is automatically pre-flight checked. Immediately after firing, the in-flight missile is acquired by a broad-beam stabilised tracking radar, which is automatically switched to narrow beam as the missile stabilises on to its computed flight path. At the optimum position for attack, the torpedo is released and lowered into the water by parachute. On water impact, the parachute connections to the torpedo are disengaged and the torpedo proceeds on a target homing run. Meanwhile, the flight vehicle continues on a flight path to take it out of the target zone.

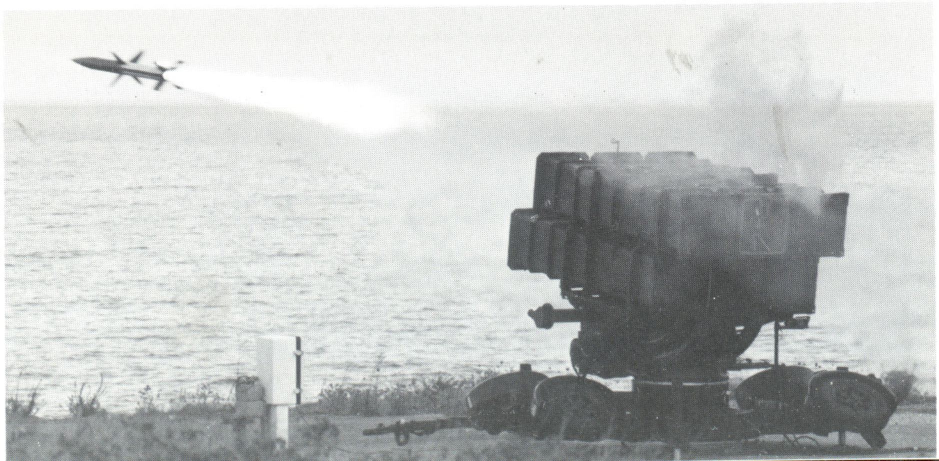
Indigo-MEI

Italy

Surface-to-air short-range missile. In production and service.

Prime contractor: Sistel-Sistemi Elettronici SpA
Powered by: Solid-propellant rocket motor of 8,267lb (3,750kg) st
Airframe: Cylindrical light alloy body with pointed ogival nose. Movable cruciform wings mid-way along body, indexed in line with fixed cruciform tail-fins
Guidance and Control: Beam-riding/radar command guidance. Control by movable cruciform wings
Warhead: High-explosive warhead of fragmentation type, with Hawker Siddeley Dynamics impact/infra-red proximity fuse. Weight 46lb (21kg)
Length: 10ft 10in (3.30m)
Body diameter: 7.7in (0.195m)
Wing span: 2ft 8in (0.813m)
Launch weight: 265lb (120kg)
Max speed: Mach 2.5

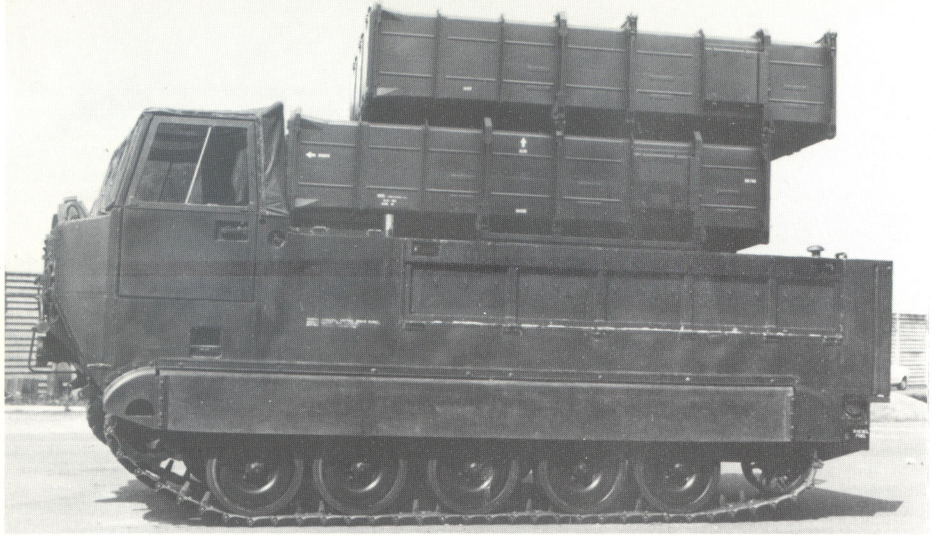
Below: Indigo-MEI launch from a trailer.

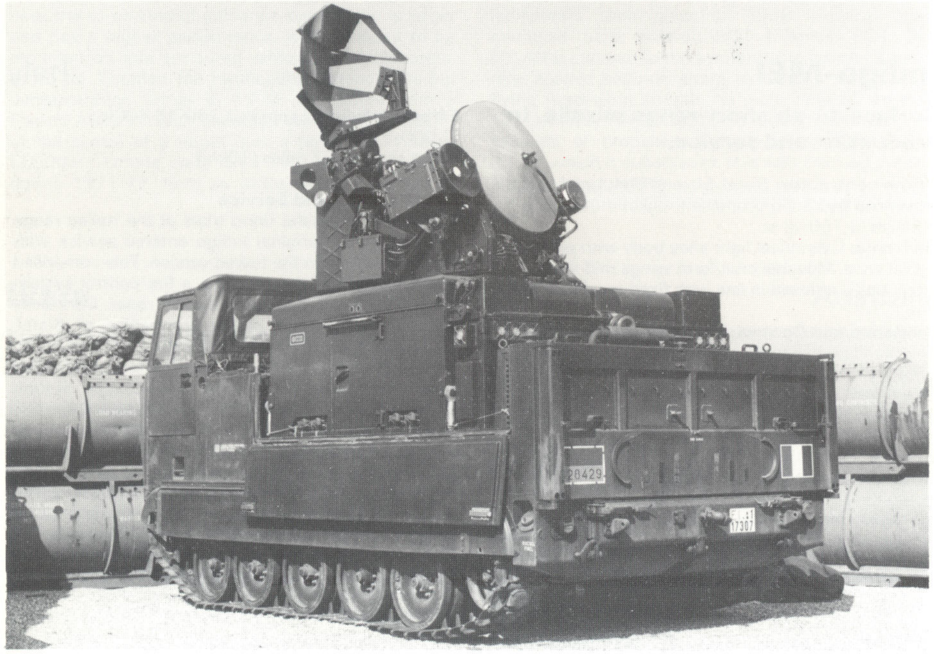


Effective height: approx 3,280-16,400ft (1,000-5,000m)
Slant range: 6.2 miles (10km)

Development and Service

Following successful firing trials at the Italian range in Sardinia, the original Indigo entered service with the Italian Army in the towed version. This comprised trailer launchers, power units, a fire control system and LPD/20 pulse Doppler search radar. Contraves Italiana, one of the parent companies of Sistel, developed an integration kit enabling the missile to be operated by anti-aircraft gun batteries equipped with the Super Fledermaus fire control system designed by Contraves AG of Switzerland. The original Indigo is no longer in production or service. It has been superseded by the all-weather Indigo-MEI. Although the latter can be trailer or ground launched, it is normally a self-propelled missile system, based on M548 tracked vehicles. A battery comprises a carrier vehicle with search and tracking radars (Selenia radars replacing the original Thomson-CSF Eldorado/Mirador radars), the fire control system and





Top: Indigo-MEI tracked launch vehicle.

Above: Indigo-MEI fire control unit.

power supply; two launch vehicles with six missiles in containers each on trainable mounts; and a logistic support vehicle with six or twelve replacement missiles.

Indigo-MEI uses beam-riding guidance or can be controlled by a radar command guidance link using optical or infra-red tracking. The target is threat evaluated automatically by a Pulse Doppler MTI (Moving Target Indicator) search radar with track-while-scan technique. The target can be attacked in radar and optical modes (the latter best for fair weather, low target and critical angle interceptions), with one or more missiles. Infra-red flares housed in the tail fins allow IR tracking. One fin also carries a telemetry transmitter antenna for use with a telemetry and training head.

Development started in 1971 and Indigo-MEI was tested by the Italian Army in 1977. It has now been selected by the Italian Army to provide protection for tanks and troops on the move and for defending fixed installations against helicopter and fixed-wing aircraft attack.

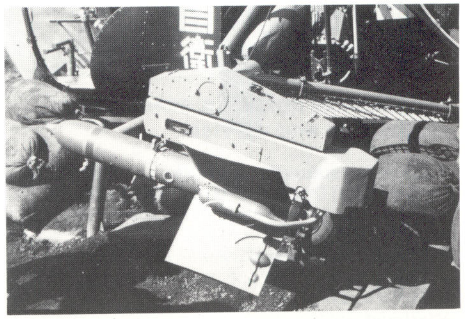
KAM-3D (Type 64 ATM-1) Japan

Anti-tank missile. In service.

Prime contractor: Kawasaki Heavy Industries Ltd
Powered by: Two-stage solid-propellant rocket motor, first stage rated at 286lb (130kg) st and second stage at 33lb (15kg) st
Airframe: Cylindrical body, with a blunt-tip conical centre-body on the rounded nose. Large rear-mounted cruciform wings, of all-metal construction, each with full-span trailing-edge spoiler
Guidance and Control: Wire guidance, with gyro-stabilisation. Control by spoilers on wings
Warhead: High-explosive
Length: 3ft 4in (1.02m)
Body diameter: 4.7in (0.12m)
Wing span: 1ft 11.5in (0.60m)
Launch weight: 34.6lb (15.7kg)
Cruising speed: 190mph (306km/h)
Range limits: 1,150-5,900ft (350-1,800m)

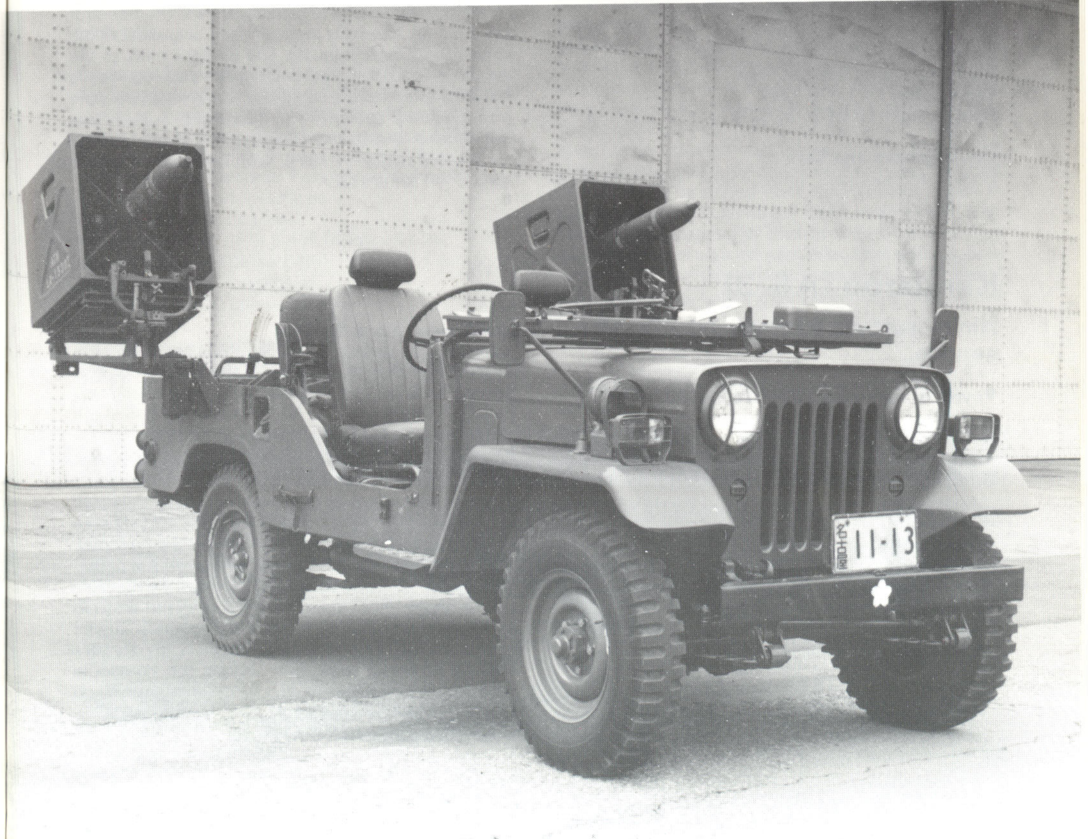
Development and Service

Kawasaki started development of this missile in 1957, under contract to the Technical Research and Development Institute of the Japan Defence Agency. Seven years later, after several hundred rounds had been test fired, production was authorised for the Japan Ground Self-Defence Force, under the official designation Type 64 ATM. Experience has shown that the KAM-3D's velocity control system is so effective that three out of four unskilled operators can hit the target with their first round after simulator training. Skilled operators can achieve a 95% success rate. A two-man firing team is standard, using a push-button control box. The KAM-3D can be fired by infantry as single rounds or from multiple-round emplacements. It is also carried on jeeps and helicopters. Optical tracking is aided by a flare in daytime; at night the rocket exhaust provides adequate visual reference.



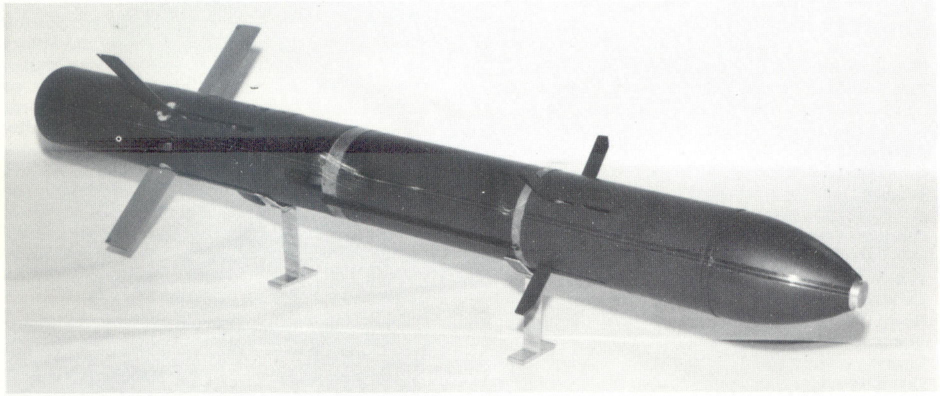
Right: KAM-3D on a helicopter.

Below: Jeep equipped with two KAM-3Ds in box launchers.



KAM-9 (TAN-SSM)

Japan



Anti-tank or anti-ship missile. In production and service.

Prime contractor: Kawasaki Heavy Industries Ltd
Powered by: Daicel dual-thrust solid-propellant sustainer. Nippon Oils and Fats Co solid-propellant rocket booster
Guidance and Control: Nippon Electric Co wire-guidance system, with optical aiming and probably infra-red tracking
Warhead: Hollow charge with piezoelectric fuse or semi-armour piercing high-explosive with impact/electromagnetic fuse
Length: 4ft 11in (1.50m)
Body diameter: 5.9in (0.15m)
Wing span: 1ft 1in (0.33m)
Range: approx 9,840-13,125ft (3,000-4,000m)

Development and Service

Under development since 1964, this missile is described as a higher-performance, extended-range version of the KAM-3D, suitable for use against armoured vehicles on both land and water. It differs from the earlier missile in several important respects. It is, for example, launched from the tubular container in which it is transported and stored. In action, the container is placed on a launch and tracking unit, incorporating the firing mechanism, optical sight and missile check-out device. A booster fires briefly to eject the KAM-9 from the launch-tube. Then, at a safe distance, the sustainer fires to accelerate the missile to cruising speed. The operator has only to keep his optical sight aligned on the target. Deviations from the line-of-sight track to the target are sensed automatically and corrective signals are fed from a computer to the missile via the wire-guidance system. The launching system has two modes, direct and separate fire. Production of the KAM-9 began in 1979, with deployment by the JGSDF the same year.

Kangaroo (AS-3)

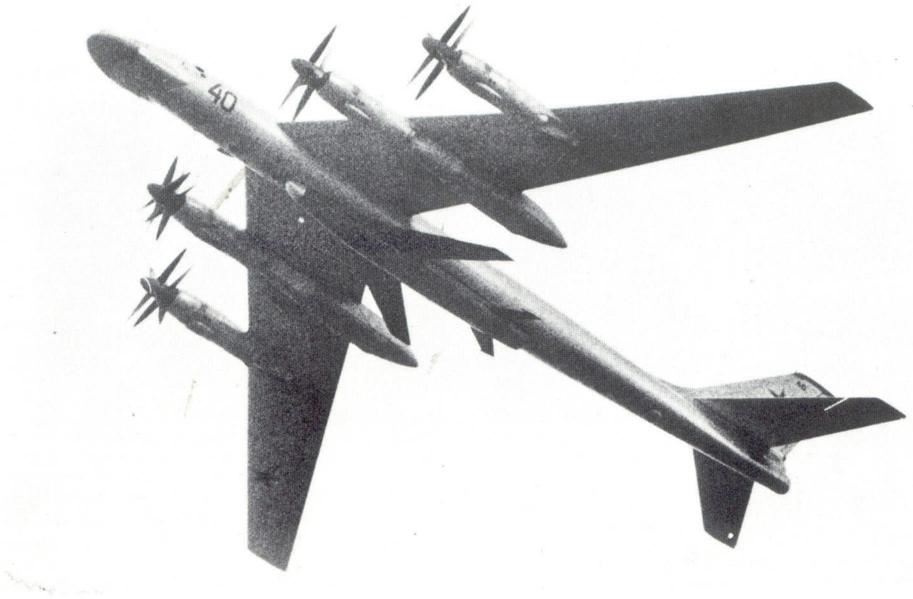
USSR

Air-to-surface strategic missile. In service.

Powered by: Unidentified turbojet engine
Airframe: Aeroplane configuration. Sweptback wings and tail unit, with vertical surfaces of rhomboid form. Nose air-intake
Guidance and Control: Aerodynamic control surfaces
Warhead: Nuclear
Length: 48ft 11in (14.9m)
Body diameter: 6ft 0.75in (1.85m)
Wing span: 30ft (9.15m)
Launch weight: 24,250lb (11,000kg)
Speed: Mach 2
Max range: 400 miles (650km)

Development and Service

'Kangaroo' is similar in size and configuration to a single-seat, single-engined swept-wing fighter aircraft. It was first displayed, clamped under the cutaway bomb bay of its Tupolev Tu-95 'Bear' mother-plane, during the fly-past at the 1961 Soviet Aviation Day display at Tushino Airport, Moscow. Further details became available subsequently when a Soviet film showed a 'Kangaroo' being released from a Tu-95 in flight. In particular, the film showed the shape of the vertical tail surface for the first time, and confirmed that the ram air-intake of 'Kangaroo' is blanked off by a duct fairing under the Tu-95's belly in flight. This may convey compressed air from an auxiliary power unit to start the missile's engine before launch. A large radar scanner in the Tu-95's nose is probably used to compute the course to target, so that 'Kangaroo' can be directed initially on the correct compass bearing.



Kelt (AS-5)

USSR

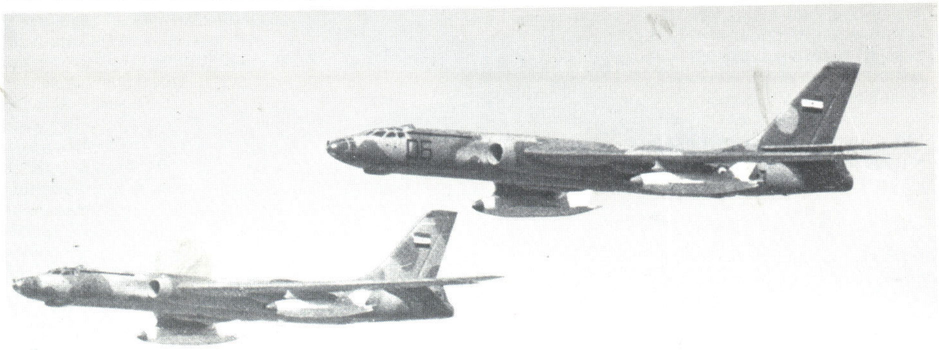
Air-to-surface stand-off missile. In service.

Powered by: Unidentified type of rocket motor
Airframe: Aeroplane configuration, basically similar to that of 'Kennel', with sweptback wings and vertical tail surfaces. Rounded nose radome. Fairing under fuselage similar in form to that of 'Styx'
Guidance and Control: Possibly radar-homing. Aerodynamic control surfaces
Length: 31ft 0in (9.45m)
Body diameter: 3ft 3.5in (1.00m)
Wing span: 15ft 0in (4.57m)
Cruising speed: Transonic
Range: over 100 miles (160km)

Development and Service

The underwing pylon on which 'Kelt' is carried by the Tu-16 'Badger' bomber appears to be more massive than that used for 'Kennel'. This suggests that 'Kelt' is a heavier weapon than its turbojet-powered predecessor. It may also offer a higher degree of accuracy, as the ram-air intake and radome of the 'Kennel' are replaced by a hemispherical nose fairing thought to contain a larger radar. Published reports have implied that 'Kelt' is carried as a standard anti-shipping missile by Tu-16s of the Soviet Naval Air Arm, which operate over areas like the North Sea and Mediterranean. Twenty-five 'Kelts' are reported to have been launched from such aircraft, based in Egypt, during the October 1973 Arab-Israeli war. Twenty were claimed as destroyed by air and ground defences; the others hit two radar sites and a supply centre in Sinai. Considerably more than 1,000 'Kelts' are believed to have been delivered to the Soviet forces.

Below: 'Kelt' missiles carried by Tu-16 'Badger' bombers.



Kerry (AS-7)

USSR

Air-to-surface tactical missile. In service.

Guidance and Control: Probably radio command guidance
Launch weight: 2,650lb (1,200kg)
Range: 6.2 miles (10km)

Much smaller than any other Soviet air-to-surface guided missile yet identified, 'Kerry' is reported to be a tactical weapon carried by MiG-27, Su-17, Su-19 and Su-20 ground attack aircraft.

Kingfish (AS-6)

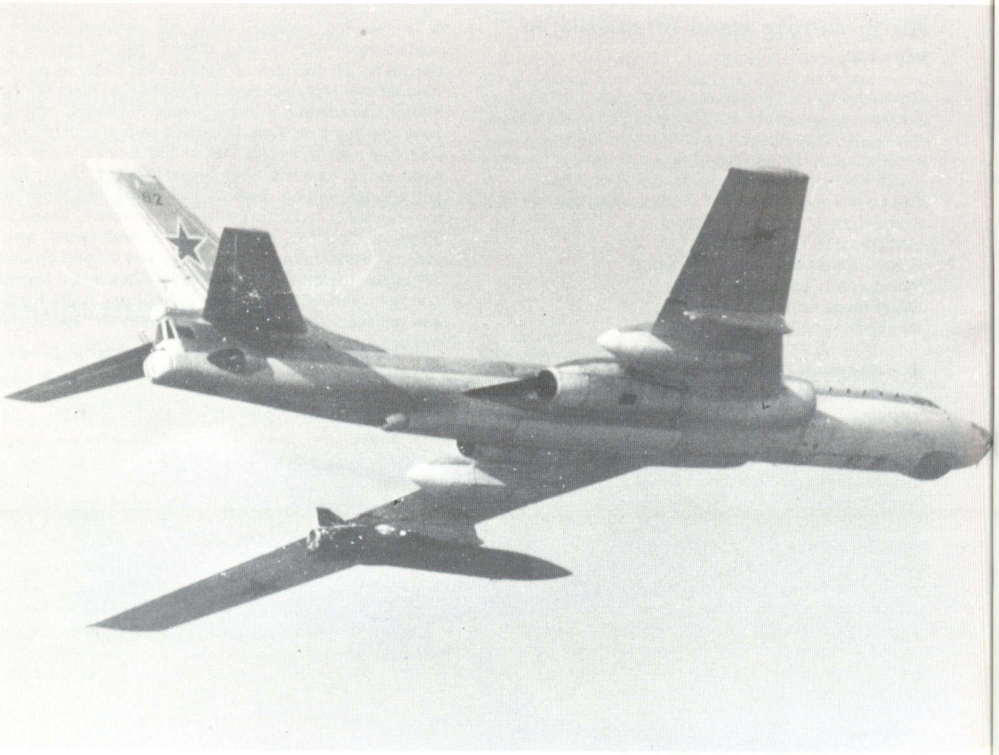
USSR

Air-to-surface stand-off missile. In service.

Powered by: Liquid-propellant rocket motor
Airframe: Cylindrical body with ogival nose, short-span wings and cruciform tail unit with a folding ventral fin
Guidance and Control: Inertial midcourse guidance. Active radar terminal homing
Warhead: Nuclear or possibly high-explosive
Length: 34ft 6in (10.50m)
Wing span: 8ft 2in (2.50m)
Cruising speed: Mach 3
Range: 135 miles (220km)

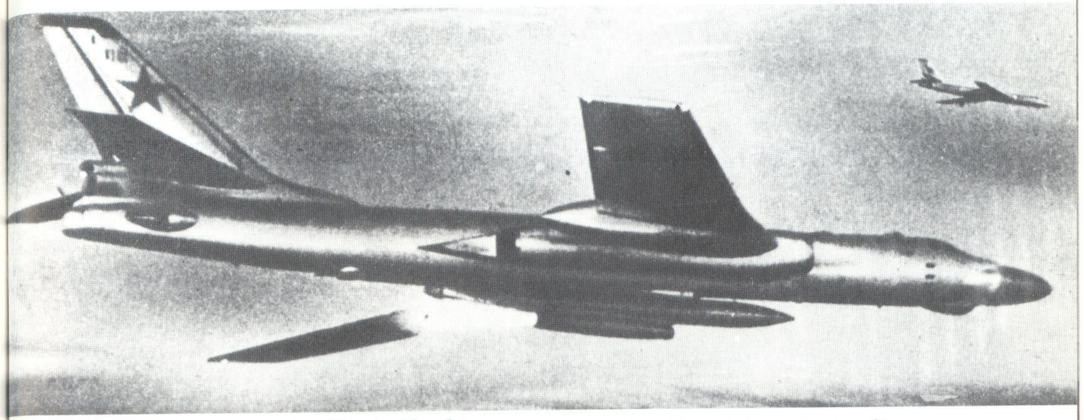
Development and Service
This very formidable and highly accurate missile is carried by Tu-16 'Badger' and Tu-26 'Backfire' bombers of the Soviet forces. It was first photographed in late 1977 while being carried by a Tu-16 near the coast of Japan. Reports have suggested that it is normally launched at an altitude of 36,000ft (11,000m), where it climbs to a greater height. Its warhead could be in the 200-kiloton yield range.

Below: 'Kingfish' missiles carried by a Tu-16 'Badger'.



Kipper (AS-2)

USSR



Above: 'Kipper' launch from a 'Badger-C'.

Air-to-surface stand-off missile. In service.

Powered by: Unidentified turbojet engine
Airframe: Aeroplane configuration, with cylindrical body, ogival nose-cone, mid-set sweptback wings and conventional sweptback tail surfaces. Engine slung under rear fuselage in pod
Guidance and Control: Probably radio command with active terminal homing
Warhead: Nuclear
Length: 31ft 0in (9.5m)
Body diameter: 2ft 11.5in (0.90m)
Wing span: 16ft (4.88m)
Launch weight: 9,260lb (4,200kg)
Cruising speed: Mach 1.2
Max range: 132 miles (213km)

Development and Service
Like 'Kangaroo' and 'Kitchen', this anti-shipping missile put in a surprise first appearance in the 1961 Soviet Aviation Day display at Tushino Airport, Moscow. It was seen to be similar in general configuration to the American Hound Dog, but smaller and of less refined form. 'Kipper' is carried by Tu-16 twin-jet bombers of the Soviet Naval Air Arm, clasped under the modified bomb-bay. This version of the Tu-16 is known to NATO as 'Badger-C', and has radar in a wide nose radome, presumably for detecting and fixing the position of the target before 'Kipper' is launched.

'Badger-Cs' have been reported over the North Sea and over the Mediterranean. 'Kipper' could clearly be used against targets on land as well as at sea.

Kitchen (AS-4)

USSR

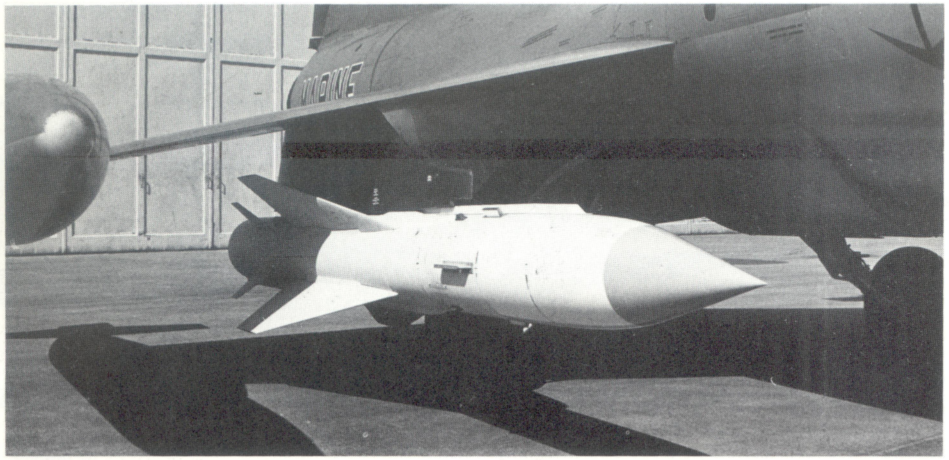
Air-to-surface strategic missile. In service.

Powered by: Probably liquid-propellant rocket motor
Airframe: Aeroplane configuration. Basically-cylindrical body, with short-span delta wings and cruciform tail surfaces
Warhead: Nuclear
Length: 37ft 0in (11.3m)
Body diameter: 1ft 7.75in (0.50m)
Wing span: 8ft 0in (2.45m)
Launch weight: over 13,225lb (6,000kg)
Cruising speed: over Mach 2
Range: 185 miles (300km) at low altitude

Development and Service
Although this weapon was first identified at the 1961 Soviet Aviation Day display, little is known about it. The commentator at Tushino Airport then referred to the Tu-22 'Blinder' carrying 'Kitchen' as the spearhead of the Soviet strategic rocket force, and most of the 22 Tu-22s which took part in the 1967 display at Domodedovo were armed with this missile. 'Kitchen', or a development of it, is also carried by the Tu-95 'Bear' and is one of the missiles that can be carried by the Tupolev Tu-26 'Backfire-B' swing-wing bomber which has followed the Tu-22 in Soviet Air Force and Navy service. About 1,000 'Kitchens' are believed to have been delivered by 1976.

Kormoran

Germany



Air-to-surface anti-shipping missile. In production and service.

Prime contractor: Messerschmitt-Bölkow-Blohm GmbH
Powered by: Two built-in solid-propellant boosters; solid-propellant sustainer motor
Airframe: Cylindrical body with pointed nose-cone. Cruciform sweptback wings, indexed in line with cruciform tail control surfaces. Roll-stabilised
Guidance and Control: Inertial guidance system, with active or passive terminal homing by Thomson-CSF RE576 radar homing head. Control via tail surfaces
Warhead: High-explosive, weighing 352lb (160kg)
Length: 14ft 5in (4.40m)
Body diameter: 1ft 1.5in (0.342m)
Wing span: 3ft 3.5in (1.00m)
Launch weight: 1,320lb (600kg)
Max speed: Mach 0.95
Max range: 23 miles (37km)

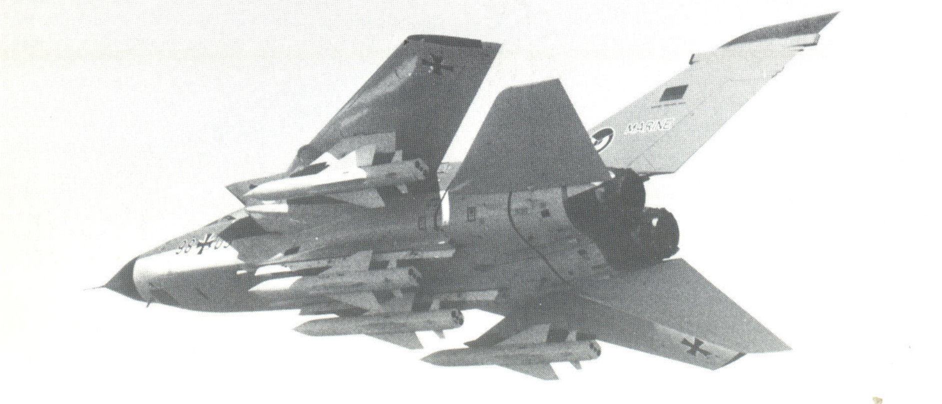
Development and Service

Largest postwar missile project undertaken in West Germany, Kormoran was developed to equip F-104G Starfighters and Tornados of the German Naval Air Service. Work on the weapon was started in 1964, as a collaborative programme by MBB and Nord-Aviation of France, who allocated the designation AS.34 to the missile. This work was financed by the Federal German government and under the design leadership of MBB. It led to the first air launch from an F-104G on 19 March 1970. Tests of fully-equipped but inert missiles against targets many miles away from the launch aircraft began with equal success in early 1971. In-plant testing of the missile was completed early in 1974, at which time official tests on F-104Gs were being carried out. Initial production began in 1975, followed by full production in 1977 of 350 missiles and 56 aircraft installations.

Aircraft equipped with Kormoran must be fitted with an autonomous navigation system (such as Doppler or inertial), a position and homing indicator, and target detection radar. Launching is possible beyond the range of most anti-aircraft defence systems, and the aircraft can break away as soon as this has taken place. Kormoran is intended to be launched normally at low level, from an aircraft maintaining a speed between Mach 0.6 and 0.95, and travels towards the target at an altitude which puts it below shipboard radar cover. Its warhead can penetrate up to 3.5in (90mm) of steel plate and it is immune to all known forms of ECM.

Below: Tornado prototype carrying four Kormoran missiles.

Above right: Kormoran in final phase of attack.



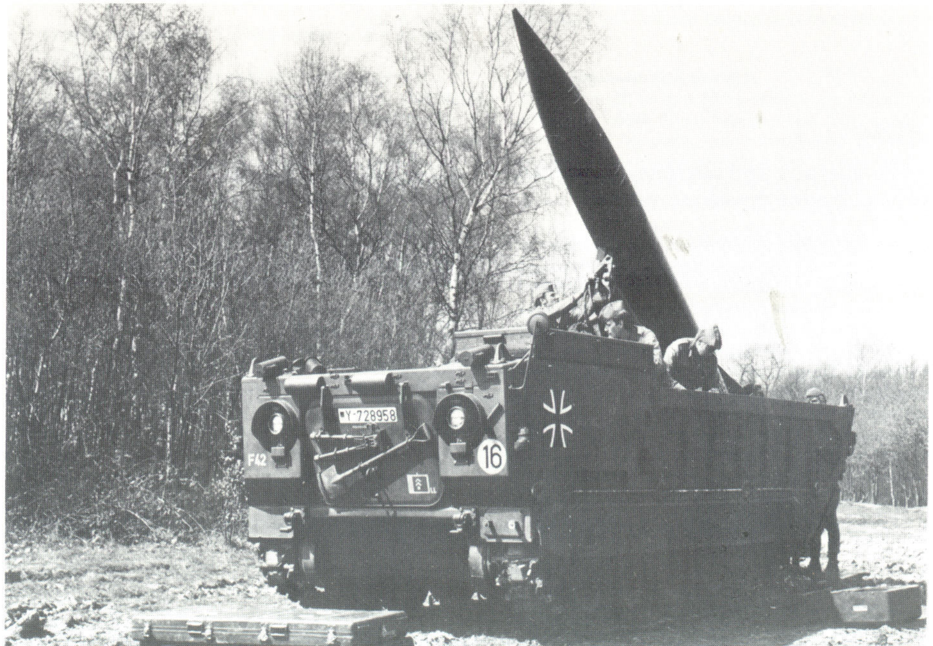
Lance (MGM-52C)

USA

Surface-to-surface artillery missile. In production and service.

Prime contractor: Vought Corporation
Powered by: Rocketdyne dual-thrust storable liquid-propellant (UDMH and IRFNA) rocket engine
Airframe: Cylindrical body, with small cruciform tail-fins and ogival nose-cone
Guidance and Control: Simplified inertial guidance system, DC-Automet
Warhead: Alternative nuclear or high-explosive types, including 450lb M234 and 1,000lb cluster warhead developed by Honeywell
Length: 20ft 2in (6.15m)
Body diameter: 1ft 10in (0.56m)
Launch weight: 2,834-3,368lb (1,286-1,528kg), depending upon warhead
Max speed: Mach 3
Max range: 75 miles (121km)

Below: Lance on a tracked launcher of the Federal German Army.



Above: Lance on a lightweight wheeled launcher.

Development and Service

Known originally as Missile B, Lance has been under development since 1962 as a replacement for the US Army's Sergeant and Honest John. It is a divisional support weapon, intended to be transported normally on an M-752 tracked erector/launch vehicle produced by FMC Corporation, with a further vehicle of the same type to carry two spare missiles and a reloading hoist. Alternatively, Lance can be fired from a lightweight wheeled launcher, produced by Orenda in Canada, which is helicopter-transportable. It requires an eight-man firing crew.

Firing trials began in March 1965, leading up to successful climatic trials in Alaska in 1969. Production was deferred to take advantage of improved performance offered by Extended Range Lance which is now the standard version. The Rocketdyne engine is interesting in that it consists of two concentrically-mounted stages. The high-thrust outer stage operates only as a launch booster and cuts out when the missile has reached its predetermined velocity. The inner stage fires simultaneously, but continues operation as the sustainer, at reduced thrust, when the booster has burned out.

Lance production began under a US Army contract awarded in January 1971, with initial delivery of the complete weapon system for evaluation three months later. It has been operational since October 1973, and now serves with US Army units in Europe and the USA. Foreign purchasers include the British, Federal German, Belgian and Italian Armies. The Netherlands and Israel have ordered the version with a 1,000lb non-nuclear cluster warhead, the larger size of which limits range.

Lasso

France

Air-to-surface and surface-to-surface missile. Under development.

Prime contractor: Aérospatiale, Division Engins Tactiques
Airframe: Cylindrical body, with pointed nose and enlarged tail section. Cruciform wings
Guidance: Wire-guidance, using optical aiming/infra-red tracking system
Warhead: High-explosive, weighing 66lb (30kg)
Length: 6ft 10.75in (2.10m)
Body diameter: 8.75in (0.22m)
Wing span: 2ft 0.5in (0.62m)
Launch weight: 211lb (96kg)
Average cruising speed: 615mph (990km/h)
Range: 6.2-6.8 miles (10-11km)

Development and Service

Lasso is being developed as a private venture by Aérospatiale as a possible AS/SS.12 replacement, and its name is an acronym of Light Anti-Surface Semi-automatic Optical. Details of the missile were first given in 1978. It is a spin-stabilised missile and has been designed to be suitable for launching from helicopters, ships and shore batteries against surface targets. It is expected to offer a hit probability of more than 90% against small targets. Lasso's capability can be enhanced by adding a thermal imaging system to the sighting unit to allow night operations.

Luz 1

Israel

Air-to-surface missile. In production.

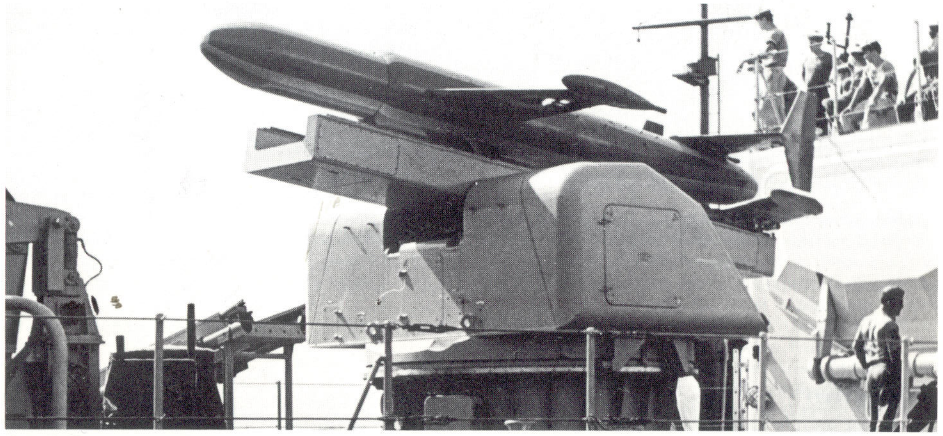
Prime contractor: Rafael Armament Development Authority and Israel Aircraft Industries
Guidance: Television-guided
Launch weight: Possibly 441lb (200kg)
Range: 50 miles (80km)

Development and Service

In 1973 it was suggested that Israel was developing an air-to-surface TV-guided missile called Luz. This has since been confirmed, although no details have been officially released. Luz 1 will arm Kfir-C2s and Phantom F-4Es of the Israeli Air Force and preparation for this has already begun. It is said to be intended mainly for destroying surface-to-air weapon systems.

Malafon

France



Above: Malafon Mk 2 on board the French destroyer *Vauquelin.*

Surface-to-surface or surface-to-underwater missile. In production and service.

Prime contractor: Société Industrielle d'Aviation Latécoère
Powered by: Unpowered in cruising flight. Launched by two SNPE Venus jettisonable solid-propellant boosters which burn for three seconds
Airframe: Aeroplane configuration. Cylindrical body, with tapered tail-cone and housing for torpedo in nose. Short pivoting wings. High-set tailplane with endplate fins. Wingtip tracking flares
Guidance and Control: Command guidance, via ship's sonar or radar, depending on submerged or surface target. 'Twist-and-steer' control by means of pivoting wings
Warhead: Acoustic-homing torpedo of 21in (53cm) diameter, weighing 1,157lb (525kg). This is ejected by inertia when a tail-parachute is streamed half-a-mile from the predicted position of the target
Length: 20ft 2.25in (6.15m)
Body diameter: 2ft 1.5in (0.65m)
Wing span: 10ft 10in (3.3m)
Launch weight: 3,305lb (1,500kg)
Max speed: 515mph (830km/h) at booster burn-out
Range: approx 1.2-8 miles (2-13km)

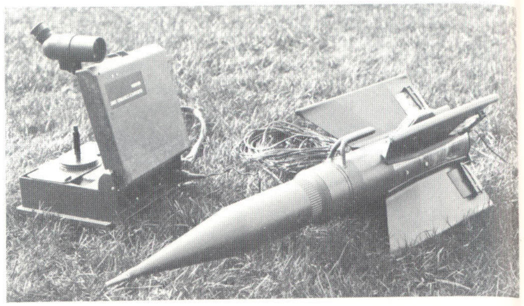
Development and Service

Development of this anti-submarine weapon system began in 1956. Initial launch trials, from the ground and from aircraft, underlined the problem of maintaining a correct cruising height after the launch-boosters had burned out. This was overcome eventually by using a radio altimeter to measure and maintain a constant altitude of about 330ft (100m) by changing the wing incidence to increase lift as the speed of the missile fell. Launch and guidance trials at sea began from the anti-submarine ship *La Galissonnière* in June 1962. The Operational sonar system and artillery-type radar were installed on this ship two years later, and operational testing of production Lat-233 Malafon Mk 2 missiles was undertaken in the first half of 1965. Subsequently, launchers have been installed on the frigates *Suffren* and *Duquesne* (each of which carries a single launcher and 13 missiles), five anti-submarine destroyers of the Type 47 Maille Brézé class, the destroyer *Aconit* and the three Type 67 Tourville class frigates.

Mamba

Germany

Portable anti-tank missile. In production and service.



Prime contractor: Messerschmitt-Bölkow-Blohm GmbH
Powered by: One-cell, dual-phase, oblique-thrust, solid-propellant rocket motor
Airframe: Cylindrical body with pointed conical nose. Large cruciform wings at rear of missile, each with a spoiler
Guidance and Control: Wire guidance by line-of-sight command, via operator's joystick controller. Control by spoilers in wings
Warhead: Shaped charge, weighing 6lb (2.7kg) and able to penetrate more than 18.7in (475mm) of steel armour. Alternative anti-tank shrapnel (ATS), able to penetrate 10in (250mm) of steel armour plus shrapnel spread, or training warheads
Length: 3ft 1.6in (0.955m)
Body diameter: 4.7in (0.12m)
Wing span: 1ft 3.7in (0.4m)
Launch weight: 24.7lb (11.2kg)
Max speed: 460ft (140m)/sec
Range limits: 985-6,560ft (300-2,000m)

Development and Service

Announced by MBB in 1972, Mamba is a development of the Cobra 2000. It is accelerated during flight from 35m/sec to a final speed of 140m/sec. This gives a flight duration of only 17.5 seconds over the full range. The initial low speed at close range gives the missile operator more time to react. Further help to the operator is given by the new x7 telescope and monocular eyepiece of the control unit, which allows the change from plain observation to telescope magnification without the operator moving his head.

The Mamba system comprises the missile and the control unit. The controller has four output sockets, for four missiles or three missiles and a junction box, which offers a total control capability of 11 missiles. Five Mambas can also be mounted on a vehicle frame if required.

Mariner

Italy

Surface-to-surface ship-launched missile. In production.

Prime contractor: Sistel-Sistemi Elettronici SpA
Total weight of system: 3,527lb (1,600kg)

The Mariner is the shipborne version of the helicopter-borne Marte anti-ship missile system, employing the same SMA radar and Sistel Sea Killer Mk 2 missiles.

This combination of equipment yields a lightweight, low cost, and effective anti-ship capability for fitting in fast patrol boats and similar light craft in which the installation of heavy fire-control equipment and long-range missiles are not justified for reasons of cost, space, weight or generating capacity.

It also offers the possibility of Marte-equipped helicopters and Mariner-fitted surface craft co-operating effectively in combined operations in operational theatres where long-range missiles (guided by a homing radar installed on board the missile itself) cannot be employed.

Below: Mariner twin launcher on the stern of a missile boat.

Marte

Italy

Above: Marte launched from an SH-3D helicopter.

Air-to-surface anti-shipping missile. Under development.

Prime contractor: Sistel-Sistemi Elettronici SpA
Guidance and Control: Guidance by radar or optical command, in conjunction with radar altimeter. Control by movable wings
Total weight of system: 2,568lb (1,165kg) on SH-3D
Range: 12.4 miles (20km)

Development and Service

The Marte weapon system has been developed to give shore- or ship-based helicopters an anti-shipping capability. Sistel's Sea Killer Mk 2 missiles were chosen for the system, with slight receiver modification, to be carried by Agusta-built Sikorsky SH-3D helicopters carrying a new chin-mounted SMA X-band track-while-scan radar. Studies have been made to confirm compatibility with a variety of other helicopters, with take-off weights ranging from 6,600 to 22,050lb (3,000-10,000kg). The equipment fitted to a Marte helicopter is lightweight and easy to operate, being based on a radar which performs navigation, search and target tracking, and azimuth guidance of the missile.

In operation, after the target has been located by the helicopter's radar, the radar is switched off and the helicopter descends so that it can approach its target at the lowest practicable height above the water. At a distance from the target estimated as being just outside the missile range, the helicopter climbs to launching altitude, re-acquires the target and fires the Sea Killer missile. A radar altimeter in the missile keeps it at very low altitude above the water, although altitude can be altered during flight by command signal. Azimuth control is either by automatic radar mode or by a secondary fair-weather system, using optical sight and joystick controller.

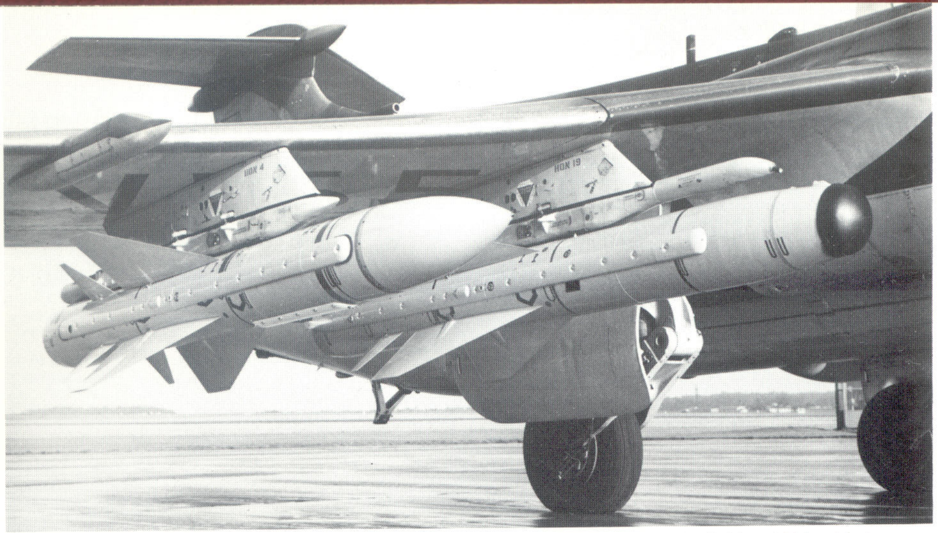
Air and ground launches of the Marte weapon system have continued. The Italian Navy has placed a pre-production contract for SH-3D installations, each comprising two missiles, launch-equipment, sonar and optical sight.

Martel (AS.37/AJ.168)

France/UK

Air-to-surface missile. In service.

Prime contractors: SA des Engins Matra (France) and British Aerospace Dynamics Group (UK)
Powered by: Solid-propellant rocket motors by Hotchkiss-Brandt and Aérospatiale
Airframe: Cylindrical body, with sweptback cruciform wings, indexed in line with cruciform tail control surfaces. AJ.168 version has a hemispherical glass nose; the AS.37 has a pointed ogival nose
Guidance and Control: AS.37 homes automatically on emissions from enemy radars. AJ.168 follows a pre-programmed course initially. Final impact is effected by the weapon operator, who is given a visual picture of the target area on a high-brightness monitor by means of a TV camera in the nose of the missile. By movement of a joystick or similar control in the cockpit of the launch aircraft, the operator aligns the TV camera on target. The missile control system than causes the Martel to align its axis with that of the TV camera. Control via tail-fins
Warhead: High-explosive, weighing 330lb (150kg), with proximity fuse



Above: Martel anti-radar (left) and TV-guided missiles under the wing of a Buccaneer.

Length: AS.37 13ft 6.25in (4.12m)
AJ.168 12ft 8.5in (3.87m)
Body diameter: 1ft 3.75in (0.40m)
Wing span: 3ft 11.25in (1.20m)
Launch weight: AS.37 1,168lb (530kg)
AJ.168 1,213lb (550kg)
Performance: Subsonic
Range: AS.37 18.5 miles (30km)

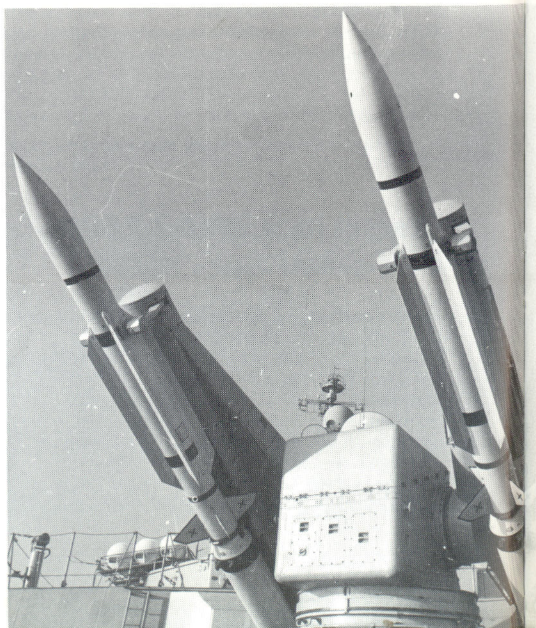
Development and Service
This very important tactical missile was developed in two forms for the RAF and French Services. Prototypes of both versions were completed in 1965-66 and development was completed, after highly successful test firings, in 1968. Evaluation started in 1969 and delivery of production Martels began in 1972. The AJ.168, carried by the RAF's Buccaneer aircraft, is a command guided weapon for stand-off attacks on surface targets and is described as having a range of 'tens of miles'. The AS.37 is an all-weather weapon for the specific task of destroying enemy radars, on which it homes automatically after launch at very low, medium or high altitudes. In other respects the two versions are identical, and both are able to operate regardless of enemy electronic countermeasures (ECM) activity. The AS.37 arms a variety of aircraft, including Mirage III-E, Jaguar and Atlantic aircraft of the French Air Force and Navy, and British Buccaneers.

Masurca MQ2

France

Ship-based surface-to-air missile. In service.

Prime contractor: Direction Technique des Constructions Navales
Powered by: Tandem two-stage solid-propellant rocket motors supplied by the Société Nationale des Poudres et Explosifs (SNPE).
Polka booster develops 75,000lb (34,000kg) st
Second stage develops 4,585lb (2,080kg) st in the Mod 2 missile, 4,785lb (2,170kg) st in the Mod 3
Airframe: Tandem two-stage missile. Cylindrical missile body with pointed ogival nose; cruciform wings of long chord and constant narrow span, indexed in line with pivoted cruciform tail control surfaces. Cylindrical jettisonable booster of larger diameter than missile, with cruciform tail-fins indexed in line with those of missile
Guidance and Control: Mod 2 version has beam-riding guidance and Mod 3 has semi-active radar homing, in each case by Thomson-CSF. Control by tail surfaces
Warhead: High-explosive, weighing 105lb (48kg), with proximity fuse



Length: 28ft 2.5in (8.60m) with booster
17ft 4.5in (5.29m) without booster
Body diameter: 1ft 4in (0.406m)
Wing span: 2ft 6in (0.77m)
Launch weight: Mod 2 4,080lb (1,850kg)
Mod 3 4,585lb (2,080kg)
Max range: Mod 2 24.9 miles (40km)
Mod 3 31 miles (50km)

Development and Service
Developed and produced by the Etablissement des Constructions et Armes Navales de Ruelle (ECAN de Ruelle), this anti-aircraft missile is carried on a twin-launcher by the French Navy frigates *Suffren* and *Duquesne*, whose main duty is to provide escort for the carriers *Foch* and *Clémenceau*. A similar launcher is carried by the cruiser *Colbert* following an extensive refit. Two missiles can be launched in a space of a few seconds against different targets. Each ship carries a total of 48 missiles.

Although there are two versions of the missile, with different guidance systems, they are virtually identical externally and a ship's twin launcher can fire a similar or mixed pair of missiles simultaneously.

Maverick (AGM-65)

USA

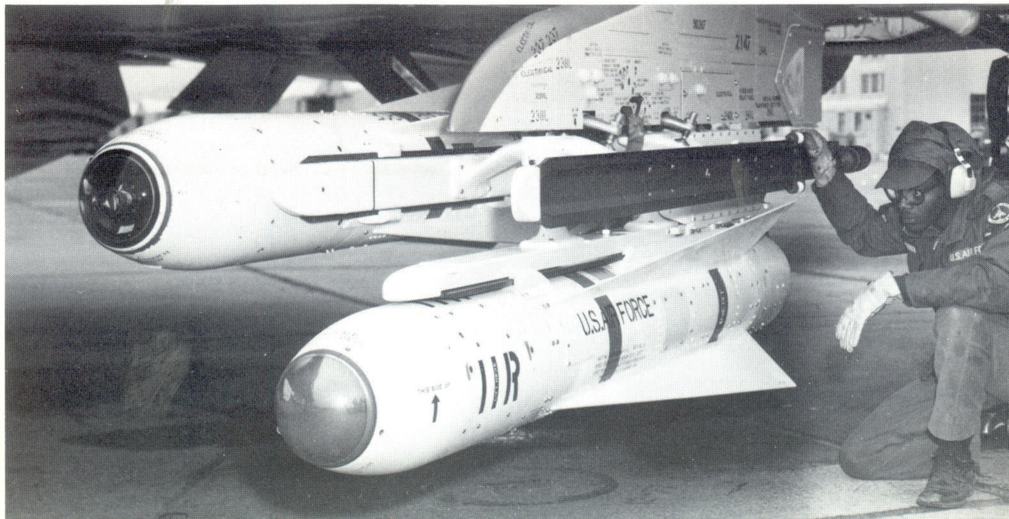
Tactical air-to-surface missile. In production and service.

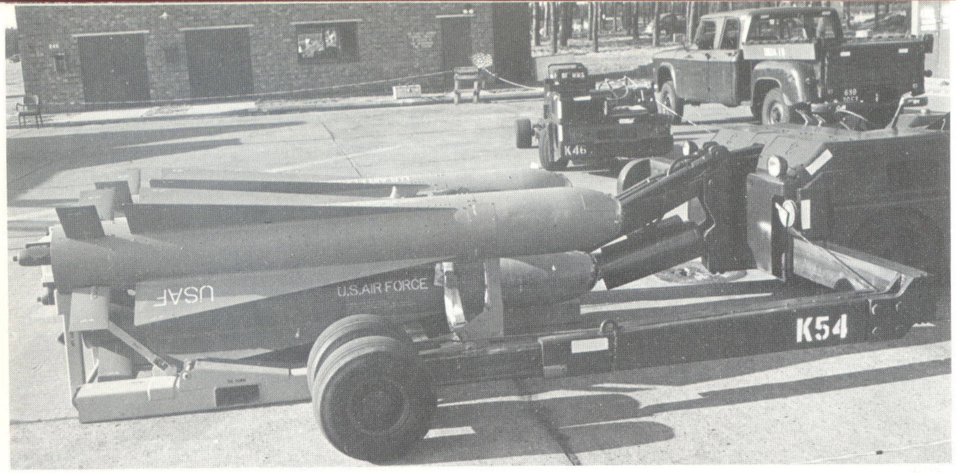
Data: AGM-65A
Prime contractor: Hughes Aircraft Company
Powered by: Thiokol TX-481 solid-propellant rocket motor
Airframe: Cylindrical body, with rounded nose. Long-chord delta wings, indexed in line with cruciform tail control surfaces, mounted close to their trailing-edges
Guidance and Control: Self-homing TV (AGM-65A/B), laser (AGM-65C) and imaging infra-red (AGM-65D) guidance systems. Control via tail fins
Warhead: Shaped charge weighing 130lb (59kg) with AGM-65A/B/D; selectable delay blast frag penetrator weighing 290lb (132kg) with AGM-65C/D
Length: 8ft 1in (2.46m)
Body diameter: 1ft 0in (0.30m)
Wing span: 2ft 4in (0.71m)
Launch weight: 462lb (210kg) with shaped charge warhead; 630lb (286kg) with blast frag penetrator warhead.
Performance: Secret, but range thought to be about 14 miles (22km)

Development and Service
Maverick is intended for use against a variety of targets such as tanks, field fortifications, radar sites, ships, command bunkers and airfields. Its development began in July 1968, under contract from the USAF Aeronautical Systems Division, to provide a 'launch and leave' missile. More than 200 performance launches of TV Maverick resulted in 92.2% direct hits. Reliability of more than 96% has been experienced, which verifies the 10-year shelf 'wooden round' maintenance concept. Deliveries of the initial AGM-65A TV-guided version began in August 1972.

Operational use of TV Maverick by the Israeli Air Force during the Yom Kippur war, in October 1973, produced results described as 'the most successful weapon of the war'. Further versions of Maverick have been developed to improve the missile's versatility. The operational AGM-65B has a 'scene magnification' TV seeker, enabling the pilot to identify and lock on to the target at longer range, or to attack smaller targets. The AGM-65C uses laser guidance, in conjunction with an air or ground target designator, enabling it to be fired by day or night. Flight testing of the AGM-65C began in 1979, and

Below: Maverick with new imaging infra-red seeker (lower).





Above: *AGM-65A Mavericks with TV guidance.*

this version is expected to go into service with the USMC. The AGM-65D is another day or night adverse weather version, with an imaging infra-red (IIR) seeker which produces an image on a screen by sensing small differences in heat radiated by objects viewed. Flight testing will begin in spring 1980 and production for the USAF could begin in 1983. A large new penetrator warhead to arm Maverick is also under development.

MD-660 (Jericho) and Ze'ev

Israel

Surface-to-surface bombardment missile.

Prime contractor: Israel Aircraft Industries Ltd
Powered by: Solid-propellant motors
Airframe: Two-stage missile
Warhead: Probably alternative nuclear or high-explosive
Airframe, Dimensions and Weights: Secret
Max range: 280 miles (450km)

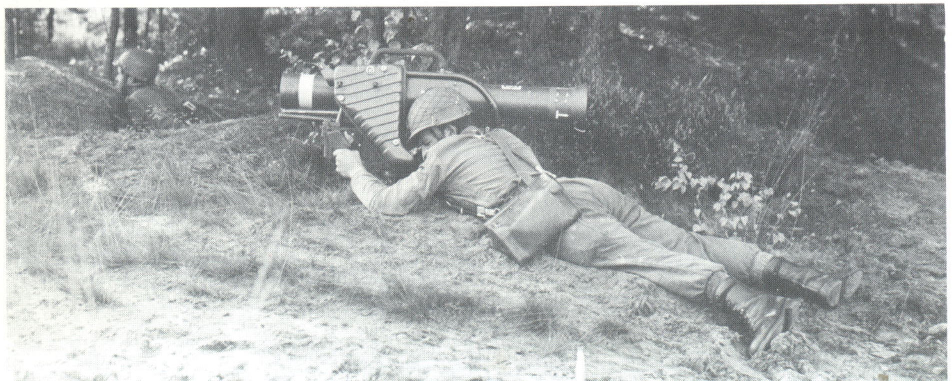
Development and Service

No details have come officially from Israeli sources to confirm reports of the existence of this mobile, ramp-launched weapon. The fact remains that Israel possesses the capability of manufacturing nuclear warheads at the Dimona reactor centre near the Dead Sea.

The designation MD-660 implies that the early development of this missile system was undertaken by Avions Marcel Dassault of France on behalf of the Israeli Government; and sea trials of a weapon named Jericho were reported to be taking place in the Mediterranean, off Toulon, in the Spring of 1968. Whether or not Jericho is related to the MD-660 cannot be verified and, anyway, may not exist as an operational weapon. Reports have indicated the possible existence of another Israeli battlefield weapon known as Ze'ev (Wolf). It is said to exist in two forms, the first carrying a 352lb (160kg) warhead over a range of just 1,000m, and the second carrying a 154lb (70kg) warhead over 4,500m. These reports cannot be verified.

MILAN

France/Germany



Infantry anti-tank missile. In production and service.

Prime contractor: Euromissile (Aérospatiale, Division Engins Tactiques/Messerschmitt-Bölkow-Blohm GmbH)
Powered by: Ejected from launch tube by booster charge. Dual-thrust solid-propellant sustainer rocket motor
Airframe: Basically cylindrical body, with fore and aft sections of larger diameter than centre portion. Four flip-out tail-fins
Guidance and Control: Wire guidance, using TCA optical aiming/infra-red tracking system. Spin-stabilised by tail-fins. Control by jet-deflection
Warhead: Hollow charge
Length: 2ft 5.5in (0.755m)
Body diameter: 4.6in (0.116m)
Fin span: 10.5in (0.266m)
Launch weight: 14.8lb (6.7kg)
Max speed: 447mph (720km/h)
Range limits: 83-6,560ft (25-2,000m)

Development and Service

MILAN (Missile d'Infanterie Léger ANti-tank) is one of three modern-generation battlefield weapon systems developed jointly by Aérospatiale and MBB, the others being HOT and Roland. It is typical of many current missiles in being fired from its transport container, which is simply placed on a lightweight launch and guidance unit when required for use. The latter unit embodies the firing mechanism, an optical sight with ×7 magnification, an infra-red goniometer and the guidance electronics. One man can carry the complete weapon system, accompanied by a colleague carrying two spare missiles. It can also be used from any type of vehicle without modification of the system, and is already mounted on the German Kraka truck and will be mounted on the French VAB Front Armoured Vehicle (Véhicule de Combat Anti-char version).

Compared with the missiles it replaces, MILAN is a high-speed weapon, reducing the opportunity for effective counter-fire from the target. Its initial velocity of 75m/sec is increased to 130m/sec during boost phase, and to 200m/sec in sustainer phase. Guidance is by the TCA system. Once the operator has acquired the target visually, he tracks it and fires the missile. His sight is linked to an infra-red missile tracking system and electronics equipment which processes the data and transmits command signals to the missile to keep in on the line-of-sight course to the target.

Over short ranges, MILAN can be used as a rocket launcher, and claims have been made for its effectiveness as a surface-to-air weapon to protect ground targets against head-on attack by helicopters and low-flying fixed-wing aircraft. Development testing of the basic weapon system was completed by 1971. Initial orders for 22,000 missiles and 800 launchers were made for the French and German armies. By mid-1978, orders had been raised to over 76,000 missiles and 3,000 launchers, to arm the forces of nearly 20 countries. MILAN will also be licence-built in the UK for the British Army, following on the delivery of the Euromissile-built missiles, which are now in service. A thermal imaging system has been developed to give the missile night-firing capability. The system is expected to enter service in 1981.

Minuteman (LGM-30)

USA

Intercontinental ballistic missile. In service.

Data: LGM-30G Minuteman III
Prime contractor: Boeing Aerospace Company
Powered by: First stage Thiokol M-55E solid-propellant motor of approx 200,600lb (91,000kg) thrust
Second stage Aerojet SR19-AJ-1 of 60,030lb (27,500kg) thrust
Third stage Aerojet/Thiokol SR73-AJ-1 of 34,170lb (15,500kg) thrust
Airframe: Three-stage cylindrical missile. Two

Right: Minuteman III launch.

Above: Minuteman II in its silo.

upper stages have smaller diameter than first stage. Ogival nose fairing covers warhead. No fins or wings
Guidance and Control: Inertial guidance system by Autonetics Division of Rockwell International. First stage control by four swivelling nozzles. Second and third stages controlled by fluid injection into single nozzle
Warhead: Thermonuclear, in multiple individually-targetable re-entry vehicles (MIRV)
Length: 59ft 10in (18.20m)
Max body diameter: 6ft 0in (1.83m)
Launch weight: 76,000lb (34,475kg)
Max speed: 15,000mph (24,000km/h)
Max range: over 8,075 miles (13,000km)

Development and Service

Minuteman was designed as a second-generation ICBM to supersede the earlier liquid-propellant Atlas and Titan. Its solid-propellant motors enable it to be stored at instant readiness in below-ground silo launchers. Although much smaller and lighter in weight than the first-generation weapons, its range is similar. The warhead is smaller, but the use of MIRV warheads of Minuteman III increases enormously the possibility of penetrating enemy defence systems.

Two versions of Minuteman are currently operational. Wings I at Malmstrom AFB, Montana, IV at Whiteman AFB, Missouri, and VI at Grand Forks, Utah, have LGM-30F Minuteman IIs, 59ft 10in (18.20m) long, with a weight of 70,000lb (31,750kg) and range of 7,000 miles (11,265km). Each successive stage is smaller than the one before, with a still-smaller cylindrical warhead of two megatons in an Avco Type II B/C re-entry vehicle. Minuteman IIIs equip Wing II at Ellsworth AFB, South Dakota, Wing III at Minot AFB, N Dakota, and Wing V at Warren AFB, Wyoming. These are similar in length to Minuteman IIs but weigh 76,000lb (34,475kg) and have a range of over 8,075 miles (13,000km). The force comprises 450 LGM-30Fs and 550 LGM-30Gs.

The 200 silo launchers of Wing 1 are dispersed over an area of 18,000 sq miles (46,600km^2). Each silo is 80ft (24.4m) deep. Two Strategic Air Command officers control each flight of 10 missiles from an underground launch centre. Airborne control can be exercised from KC-135 command post aircraft.

In a programme designed to enhance the capability of the Minuteman force, the new Mk 12A re-entry vehicle has been developed to replace the current Mk 12 in some Minuteman IIIs. The Mk 12A has three 350KT yield warheads instead of three 200KT warheads in the Mk 12, and has miniaturised arming and firing systems. Silos have also been upgraded.

Minuteman is no longer in production, the final missile being delivered on 30 November 1978.

Mosquito

Switzerland/Italy

Lightweight anti-tank missile. In service.

Prime contractor: Contraves Italiana SpA
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical glass-fibre body with pointed conical nose. Folding cruciform wings of sandwich construction, each with trailing-edge vibrating spoiler
Guidance and Control: Wire guidance by command to line-of-sight, with roll-stabilisation by powder-driven gyro. Control by vibrating spoilers on wings
Warhead: Hollow charge, weighing 9lb (4kg) and able to penetrate more than 26in (660mm) of armour, or fragmentation type
Length: 3ft 7.7in (1.11m)
Body diameter: 4.72in (0.12m)
Wing span: 1ft 11.6in (0.60m)
Launch weight: 31lb (14.1kg)
Cruising speed: 205mph (330km/h)
Range limits: 1,200-7,800ft (360-2,375m)

Development and Service

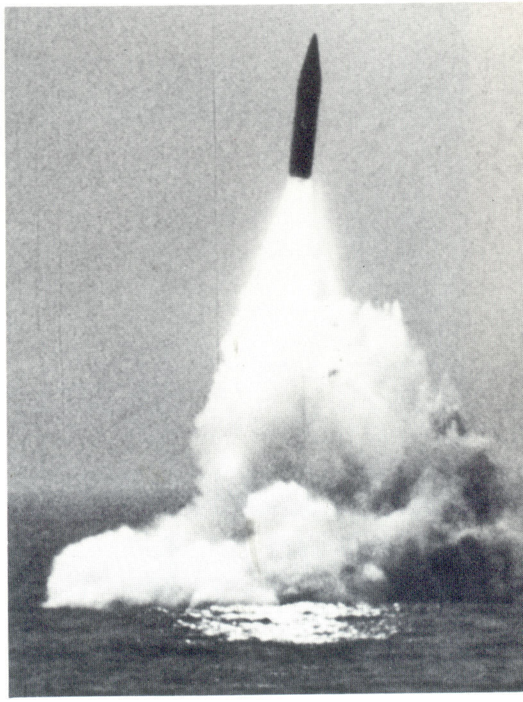
This simple, one-man, infantry anti-tank weapon was developed by Contraves-Oerlikon of Switzerland but manufactured by Contraves Italiana. It is standard equipment in the Swiss and Italian Armies, who use also a version fitted with a parachute recovery system, instead of a warhead, for training. Six Mosquitos can be carried in their container-launchers, ready for firing, by the Puch-Haflinger light cross-country vehicle. Mosquitos have also been fired successfully from Agusta-Bell 47 helicopters.

In conventional infantry use, the Mosquito is controlled and fired by means of a small control box carrying a joystick and optical sight. The container-launcher houses the missile with its warhead detached and weighs 48.5lb (22.0kg).

MSBS (M-2 and M-20)

France

Submarine-launched ballistic missile. In production and service.



Above: MSBS M-20 launch.

Prime contractor: Aérospatiale, Division Systèmes Balistiques et Spatiaux
Powered by: First stage SEP P.10 (Type 904) solid-propellant motor
Second stage SEP P.6 (Rita II) solid-propellant motor
Guidance and Control: Inertial guidance. Control by four gimballed nozzles in first stage: Freon injection into single fixed nozzle in second stage
Warhead: M-2 Nuclear, approx 500-kiloton yield
M-20 Thermonuclear, 1 megaton yield
Length: 34ft 0in (10.36m)
Body diameter: 4ft 11in (1.50m)
Launch weight: M-20 44,120lb (20,012kg)
Max range: 1,864 miles (3,000km)

Development and Service

The M-2 improved version of the MSBS became operational in the French Navy's third SNLE submarine *Foudroyant* in 1974. The submarines *Terrible* and *Redoutable*, then fitted with M-1s, have since been installed with M-4s and M-2s respectively.

In 1976, the M-20 missile entered service. Although essentially an M-2, it incorporates a new hardened re-entry vehicle system protected by fairings to improve its chances against anti-ballistic missile nuclear attack, and has a megaton strength thermonuclear payload and new penetration aids. First installed in *Indomptable*, France's fourth SNLE submarine, it is now also installed in *Tonnant*, the fifth SNLE submarine.

MSBS (M-4)

France

Submarine-launched ballistic missile. Under development.

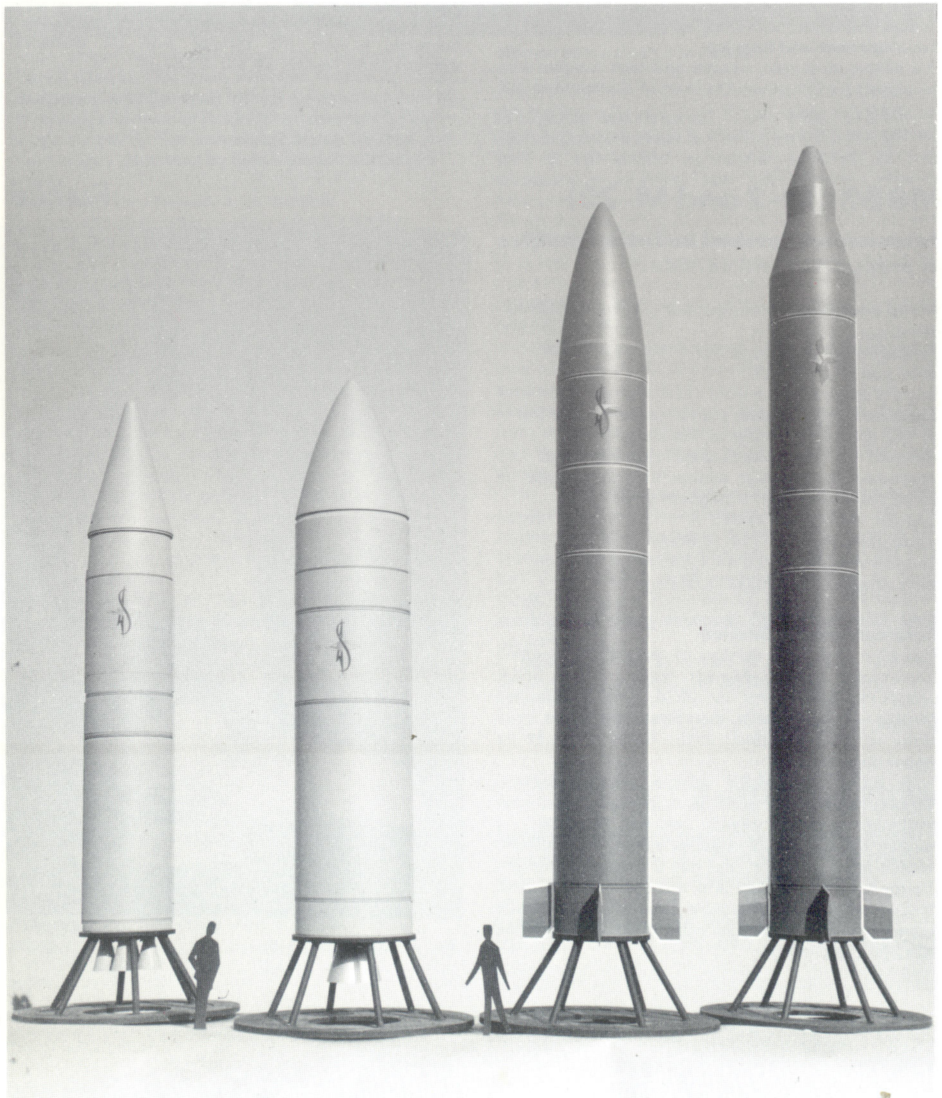
Prime contractor: Aérospatiale, Division Systèmes Balistiques et Spatiaux
Powered by: First stage 401 solid-propellant motor
Second stage 402
Third stage 403
Guidance and Control: Inertial guidance. Control of each of the three stages by single flexible nozzle
Warhead: Thermonuclear, in multiple re-entry vehicles
Length: 36ft 3in (11.05m)
Body diameter: 6ft 4in (1.93m)
Max range: 2,485 miles (4,000km)

Development and Service

The MSBS M-4 is a completely new submarine-launched ballistic missile. Its main differences compared with the earlier M-20 are that it has three stages, multiple re-entry vehicles and new motors. However, the M-4 can be launched from existing SNLE submarines after some modifications in the tubes.

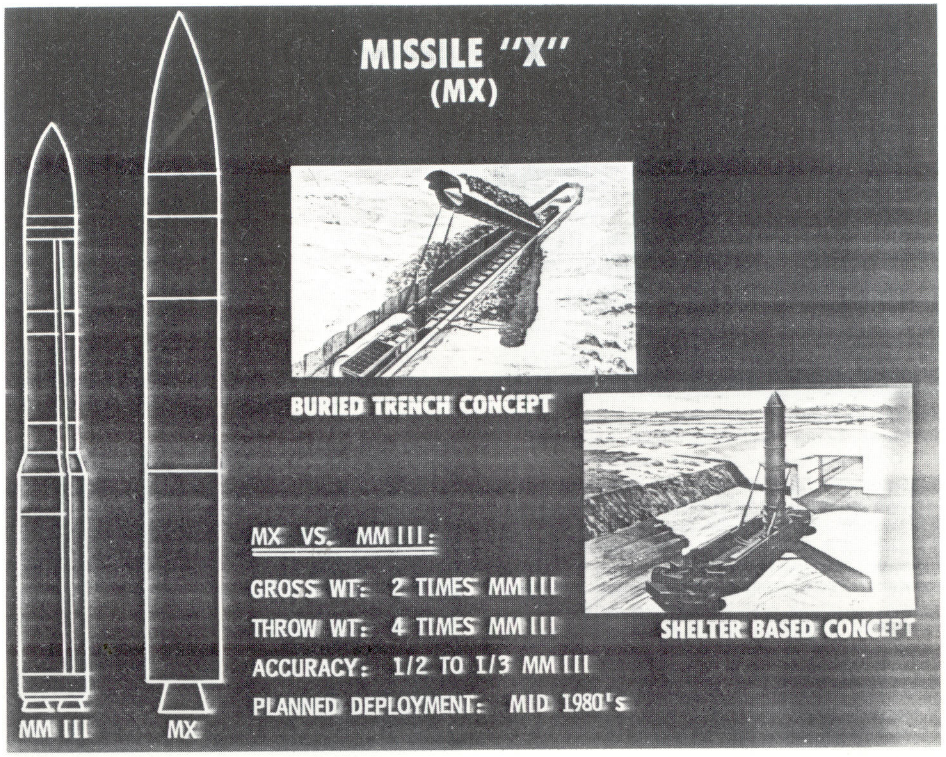
The development phase of the M-4 programme began in April 1976. The second SNLE submarine *Terrible* is currently being installed with M-4s, although operational deployment of the new system is not expected until the mid-1980s. The sixth SNLE submarine, *Inflexible*, will be fitted with M-4s.

Below: (Left to right) MSBS M-1, M-4, SSBS S-3 and S-2.



M-X

USA



Above: Artist's impression of the M-X buried trench and shelter based concepts, plus comparative size with Minuteman III missile.

Advanced intercontinental ballistic missile. Under development

Development and Service

The M-X intercontinental ballistic missile programme began in 1974, when it was apparent that a Minuteman replacement would be needed in the 1980s if the USA was to continue to deploy a realistic deterrent force in the face of the latest Soviet missiles being deployed and those currently under development, which not only have a massive increase in throw weight but threaten conventional hardened silo bases. The M-X programme will provide the technology to build a new missile with a greater throw-weight than Minuteman III, improved accuracy and one that will be based either in a long trench with hardened areas, a shelter concept or on a mobile vehicle. However, the USAF favours the trench mode and test trenches have already been dug for evaluation of erection equipment, although the shelter concept is considered a suitable back-up. It seems probable that about 200 missiles will be built if the programme is allowed to continue. Already the M-X programme has been delayed, despite the acceptance in the USA that existing silo-based missiles are vulnerable to attack. If no further delays are incurred, flight testing of the missile could begin in 1984.

Naval Crotale

France

Ship-based surface-to-air close-range weapon system. In production and service.

Prime contractor: Thomson-CSF

Development and Service

Matra's Crotale all-weather surface-to-air weapon system offered such promise that Thomson-CSF decided to develop a ship-based version as a private venture. The result was first called Murene, but later changed to Naval Crotale. It comprises one or more eight-round turret-launchers, a DRBV 26 surveillance radar, a DRBV 51 radar to acquire the target and IFF interrogation, stabilised fire control radar, a digital computer for automatic tracking and a display console. The missile can be launched by the single operator from his hardened fire control room shelter or from the central operations room. This version of Crotale has been selected by the French Navy for use aboard its ships and by at least one other navy. Firing trials began in March 1978 on board *Ile d'Oleron*, and these were followed by trials on board the destroyer *Georges Leygues*, which was the first operational vessel with Naval Crotale. The missile now also arms Tourville class frigates, *Jeanne d'Arc* helicopter cruiser and will arm all new Georges Leygues class C70 destroyers and the PH75 nuclear-powered helicopter carrier.

Nike Hercules (MIM-14B)

USA

Surface-to-air missile. In service

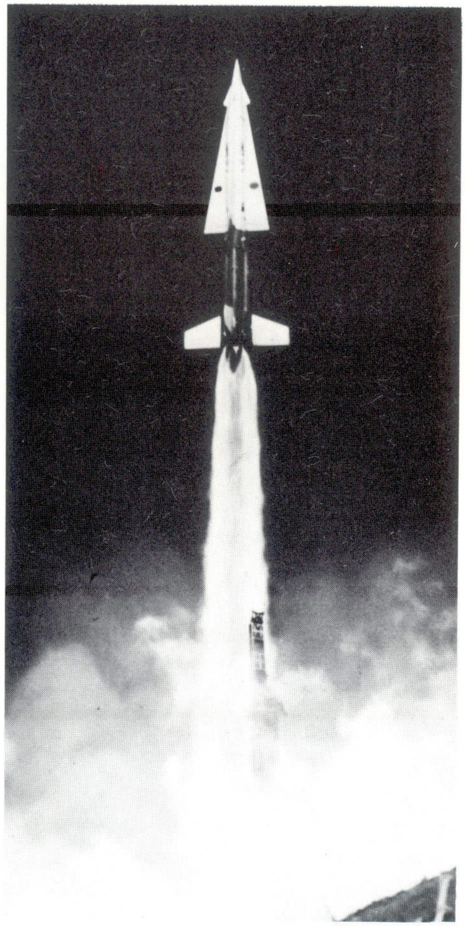
Prime contractors: Western Electric Company Inc/Mitsubishi Heavy Industries Ltd
Powered by: Thiokol solid-propellant sustainer. Hercules Inc clustered four-motor solid-propellant jettisonable booster
Airframe: Tandem two-stage missile. Basically-cylindrical missile body, tapering towards nose which carries small cruciform delta surfaces. Long-chord cruciform delta wings, each with trailing-edge control surface. Booster is made up of four cylindrical motors with cruciform stabilising fins indexed in line with missile wings.
Guidance and Control: Western Electric command system. Control by wing trailing-edge surfaces
Warhead: Alternative nuclear or high-explosive types
Length: 39ft 8in (12.10m)
Max body diameter: 2ft 7.5in (0.80m)
Wing span: 6ft 2in (1.88m)
Launch weight: 10,710lb (4,858kg)
Max speed: Mach 3.65
Max range: 87 miles (140km)
Effective ceiling: 28 miles (45km)

Development and Service

Although development of Nike Hercules was started as long ago as 1953, to replace Nike Ajax, it remained in production by Mitsubishi in Japan until recently. In the USA, where it became operational as the nation's primary anti-aircraft defence weapon in 1958, the number of launch-sites has been reduced progressively, and in 1974 it was decided to close all but two Nike Hercules battalions in the United States by the end of that year. The remaining battalions are based in Southern Florida and the Anchorage area of Alaska.

The Nike Hercules missile was developed and produced originally by the Douglas Aircraft Company, and achieved a notable early success when one Nike Hercules intercepted another at a range of 30 miles (48km) from its launch-point, and altitude of about 100,000ft (30,500m) over White Sands Missile Range in September 1960.

In operation, the target is acquired first by acquisition radars, which pass it on to the target tracking radar. When the missile is launched, another tracking radar issues command guidance and detonation instructions under the control of the weapon system's data processing equipment. In the USA, Nike Hercules batteries were integrated into the SAGE defence system, which controlled all air defence fighters and missiles. Nike Hercules is also operational in a mobile role, notably with NATO and friendly countries, using a HIPAR advanced high-power acquisition radar which greatly increases the mobility and detection capability.

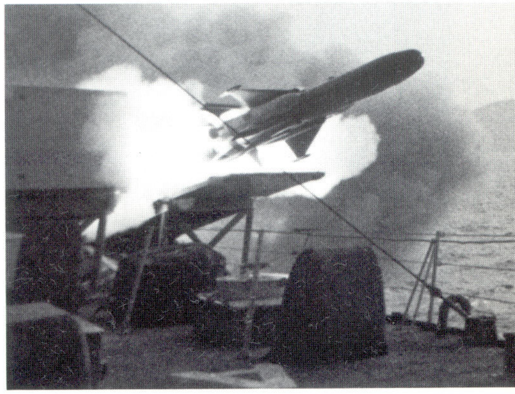


Otomat

France/Italy

Anti-shipping missile. In production and service.

Prime contractors: SA Matra (France) and Oto Melara SpA (Italy)
Powered by: Turboméca Arbizon II turbojet, rated at 882lb (400kg) st. Two side-mounted jettisonable boosters
Airframe: Cylindrical body. Four semi-circular engine air-intake ducts, each supporting a cropped-delta wing, equi-spaced around body mid-way between nose and tail. Cruciform tail control surfaces indexed in line with wings. Ogival nose-cone and tapered tail fairing
Guidance and Control: Inertial guidance, with Thomson-CSF active radar terminal homing. Tail control surfaces
Warhead: Semi-armour piercing type, weighing 460lb (210kg)
Length: 14ft 5.25in (4.40m)
Body diameter: 1ft 3.75in (0.40m) forward of ducts
Wing span: 3ft 10.75in (1.19m)
Launch weight: 1,543lb (700kg)
Max speed: Mach 0.9
Max range: 112 miles (180km)



Above: Ship-launched Otomat.

Development and Service

This missile takes its name from those of its manufacturers, *Oto* Melara and *Ma*tra. Its development was started in 1969, to provide a weapon in the same category as the French Exocet, but with a much longer range as a result of its use of a turbojet engine instead of a rocket motor. The warhead is unusually large and its effects are increased by the incendiary effect of any fuel remaining in the missile when it strikes the target.

Otomat does not require a swivelling launcher. It can be mounted in a fixed position on the launching craft, inside its delivery container which doubles as launcher. Firing is possible in all weathers, by day or night, and the missile is able to change direction up to 180 degrees, to port or starboard, to align itself on the target, which can therefore be behind the launch-ship. The basic course to the target is worked out by the shipboard radar and fire control system, with radar terminal homing on enemy ships that can be well 'over the horizon' and hence beyond the range of the ship's radar. A radio altimeter maintains a cruising height of about 80ft (25m) throughout the missile's flight, with a final attack either from low level or at the end of a steep dive after a climb started 4.35 miles (7km) from the target.

Otomat has been produced in two versions: ship-to-ship and for coastal defence. Both versions are characterised by a very long range. An air-to-sea version is under study. It has been chosen by several foreign navies, totalling about 400 missiles, to arm about 30 ships of various sizes ranging from hydrofoil patrol boats to corvettes and helicopter-carrying frigates.

The first firing of a complete missile was on 28 February 1972, at Salto Di Quirra range in Sardinia. In June 1974, the Italian Navy hydrofoil boat *Sparviero* launched its first Otomat. Within the framework of the production plan, four missiles were launched in 1978 at the Salto Di Quirra range. The complete Otomat system is in series production.

P3T

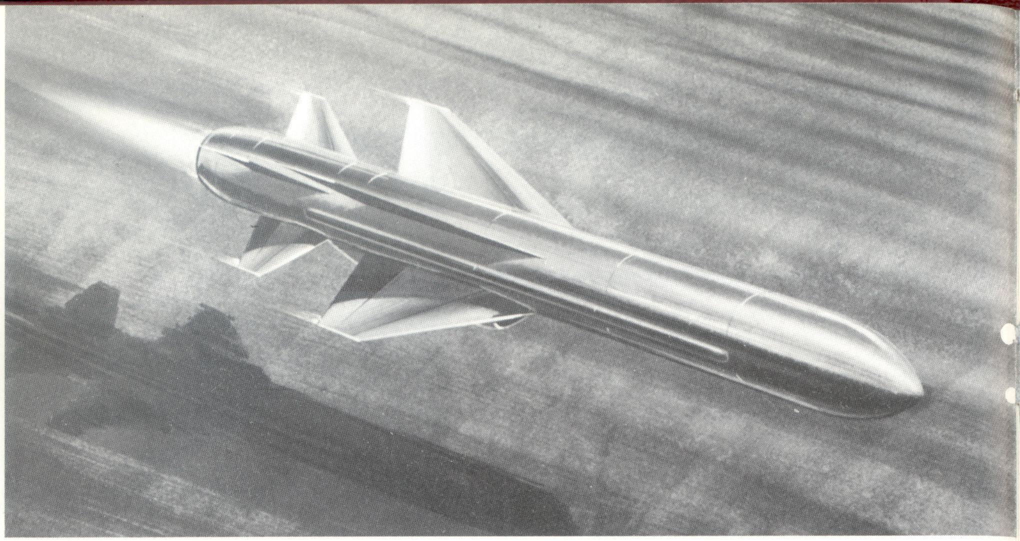
UK

Air-to-surface missile. Under development

Prime contractor: British Aerospace Dynamics Group
Powered by: Microturbo TRI-60 turbojet engine
Airframe: Cylindrical body, with sweptback cruciform wings, indexed in line with cruciform tail control surfaces. Ogival nose
Guidance and Control: Active radar guidance. Control via tail-fins

Development and Service

In August 1977, the British Minister of State for Defence announced that development was to be undertaken of a second generation air-launched sea-skimming anti-ship missile to replace the Martel with the RAF in the early 1980s. It will eventually arm RAF Buccaneers and Panavia Tornado GR Mk 1s and Royal Navy Sea Harriers. The P3T is an all-weather missile with fire-and-forget capability, which has been designed to be launched out of range of the target ship's surface-to-air defences and operate successfully against multiple targets in an electronic countermeasures environment.



Above: Artist's impression of the P3T.

Patriot (XMIM-104) USA

Surface-to-air weapon system. Under development.

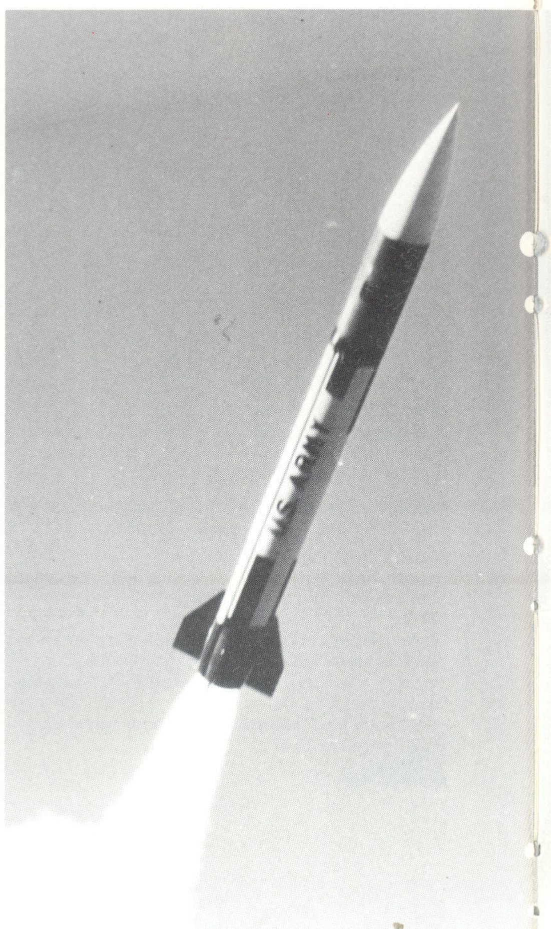
Prime contractor: Raytheon Company
Powered by: Thiokol TX-486 single-stage solid-propellant rocket motor
Airframe: Cylindrical body, with pointed ogival nose. Cruciform tail control surfaces
Guidance and Control: Command guidance, with semi-active terminal homing. Control by tail surfaces
Warhead: High-explosive
Length: 17ft 0in (5.18m)
Body diameter: 1ft 4in (0.41m)

Development and Service

Studies for a new surface-to-air weapon system known as SAM-D began in 1965, following earlier US Army study programmes known as Field Army Ballistic Missile Defense System (FABMDS) and Army Air Defense System for the 1970s (AADS-70). After evaluation of competing industry proposals, Raytheon was awarded in May 1967 a contract covering the first year's advanced development of SAM-D, which is intended to replace Improved Hawk in the 1980s and beyond. Subsequent contracts covered demonstration of the advanced guidance system, operation of the radar in its various modes and the aerodynamic capabilities of the missile, leading to demonstrations of the full capability of the fire control group.

The missile and its shipping/launch container are being developed by Martin Marietta Corporation under sub-contract from Raytheon. Four missiles in their containers will be carried by each Patriot launch vehicle, from which they will be fired either singly or in close-sequence salvos at selectable azimuths and elevations, as required. In the field, a fire section will consist of the radar unit carrying phased-array radar, an engagement control station housing a weapons control digital computer, electric power supply and up to eight Patriot missile launching stations. In action, the multi-function phased-array radar acquires the target, tracks and illuminates it, and at the same time tracks the missile into its mid-course flight path. Then, during the terminal phase, the missile acquires the illuminated target and, aided by the ground-based computer, homes on the illumination until intercept.

Ten consecutive successful flights of the Patriot missile at the White Sands Missile Range, New Mexico, before the end of August 1974, to demonstrate the structural strength and controllability during maximum manoeuvres, were followed by the start of a proof-of-principle flight test programme to demonstrate the effectiveness of the Track-Via-Missile (TVM) guidance. This phase accomplished the last of its assigned objectives on 16 September 1975, after only six firings, against non-manoeuvring and manoeuvring targets, a target flying in formation and a target at low altitude in ground clutter. By the time 19 missiles had been fired, 18 had made successful intercepts and one had been declared a 'no test'. One of the successful launches in December 1976 was the first from a tactically configured launcher. The current development programme is expected to be completed in 1980.



Paveway USA

Homing bomb system. In production and service.

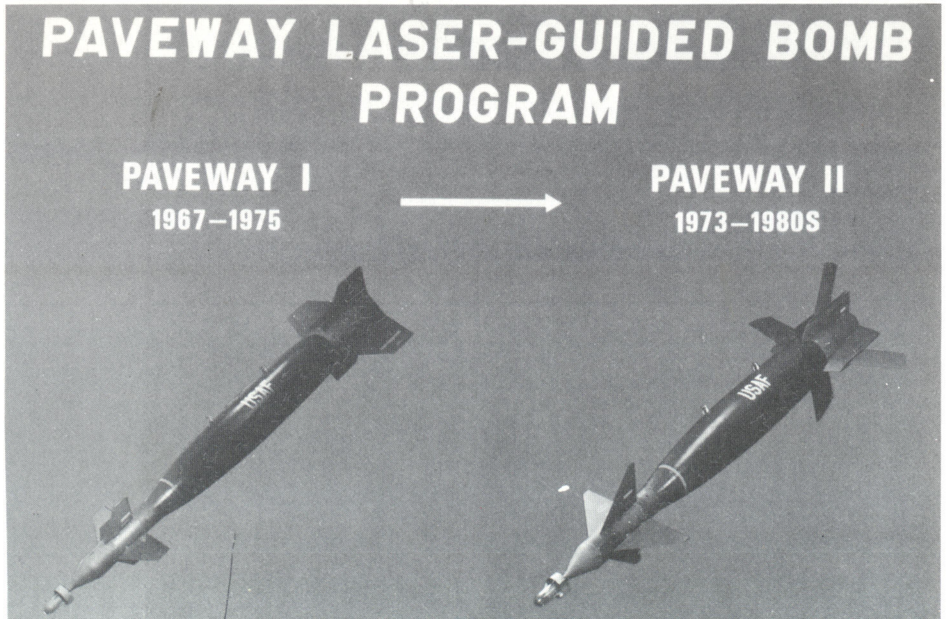
Prime contractor: Texas Instruments Inc
Guidance and Control: Texas Instruments laser seeker. Aerodynamic surfaces
Warhead: 496-2,000lb (225-907kg) bomb

Development and Service

Similar in concept to the GBU-8 (HOBOS) produced by Rockwell International, the name Paveway covers a range of low-cost modular laser homing bombs. First used operationally in 1967 during the Vietnam conflict, the Paveway I has been followed by the improved Paveway II with retractable tail fins which increase its performance and adaptability. All the versions of the weapon use the same seeker and guidance unit, with only the aerodynamic surfaces varying to conform with the bomb used.

Paveway homing bombs are in service with the US Air Force and Navy, Royal Air Force and air forces of other NATO and friendly countries, including Greece, Iran, Republic of Korea, the Netherlands, Saudi Arabia and Turkey.

Below: Paveway I and II laser-guided bombs.



Penguin

Norway

Ship-to-ship tactical missile. In production and service.

Prime contractor: A/S Kongsberg Vaapenfabrikk
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical body with swept cruciform wings mounted mid-way back. Small swept fins on tapered nose, indexed in line with wings
Guidance and Control: Inertial guidance, with infra-red terminal homing. Control by movable wings
Warhead: High-explosive, weighing 264lb (120kg), with contact fuse
Length: 10ft 0in (3.05m)
Body diameter: 11in (0.28m)
Wing span: 4ft 7in (1.40m)
Launch weight: 750lb (340kg)
Cruising speed: Mach 0.8
Max range: Mk 1 11.5 miles (18.5km)
Mk 2 17 miles (27km)

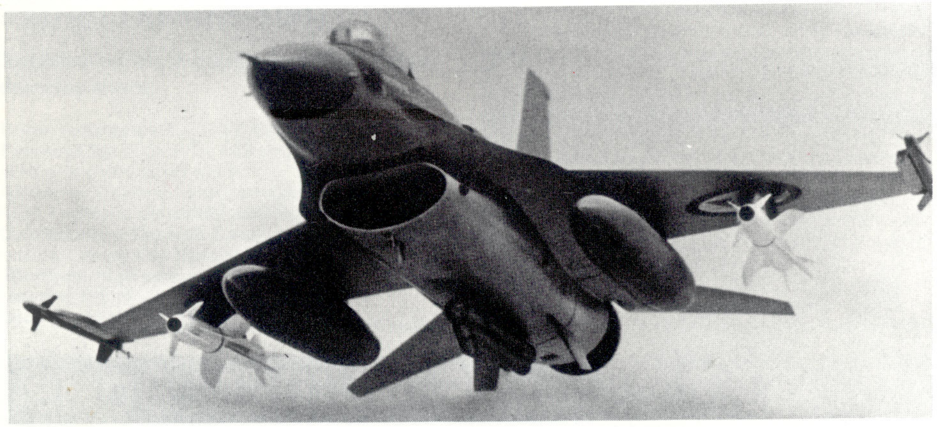
Development and Service

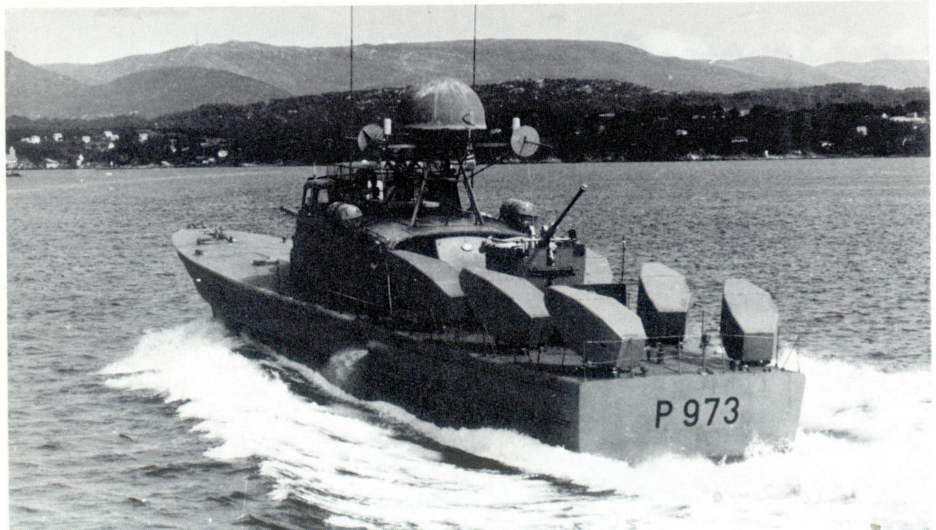
The ship-launched tactical missile is operational in the Mk 1 version on Storm class gunboats of the Royal Norwegian Navy, each of which can carry six Penguin launchers on its after deck. The Snogg class of torpedo boats each have four similar launchers; other are carried by Oslo class frigates, and by Kartal class fast attack craft of the Turkish Navy. A total of 40 Norwegians and foreign vessels carry the Mk 1 Penguin. An improved Penguin Mk 2 has been developed and is now in production for the Norwegian, Swedish and Greek navies. This version has a range of 17 miles (27km). It is expected to arm 36 vessels in total.

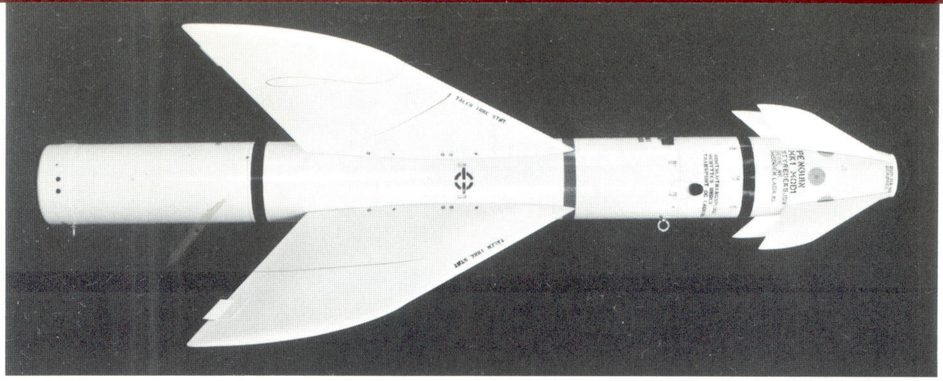
Penguin was developed by the Norwegian Defence Research Establishment and Kongsberg Vaapenfabrikk, the latter of which was then entrusted with quantity production. Penguin is fitted with a warhead similar to that of the Bullpup air-to-surface missile for which Kongsberg was European prime contractor. The container in which it is delivered serves also as the shipboard launcher and embodies the necessary launch-rail. The weapon is compatible with most existing types of naval fire-control systems, and is equally suitable for installation on shore bases for coastal defence, helicopters and other platforms. A version of Penguin, known as the Mk 3, without the booster motor and with a smaller wing span is being studied as armament for jet fighters, with particular application to the General Dynamics F-16 ordered by several NATO air forces in Europe. This version was expected to go into the development phase in 1979.

Below: Model of an F-16 fighter armed with Penguin missiles.

Bottom: Storm class patrol boat carrying six Penguin launchers.







Pershing (MGM-31A)

USA

Surface-to-surface, selective-range artillery missile. In service (Pershing Ia) and under development (Pershing II).

Data: Pershing Ia
Prime contractor: Martin Marietta Corporation
Powered by: Tandem solid-propellant rocket motors. Thiokol M-105 in first stage and Thiokol M-106 in second stage.
Airframe: Two stage missile. Basically-cylindrical body, with long tapering pointed nose-cone. Three square vanes at base of second stage, indexed in line with three delta-shape tail control surfaces on first stage
Guidance and Control: Bendix Eclipse-Pioneer Division inertial guidance system, operating until cut-off and separation of second stage. Control by first-stage tail-fins and jet deflection, and second-stage vanes.
Warhead: Nuclear, in ablative re-entry vehicle, of approx 60-400 kiloton yield
Length: 34ft 7in (10.54m)
Body diameter: 3ft 4in (1.01m)
Launch weight: 10,246lb (4,648kg)
Range limits: 100-460 miles (160-740km)

Development and Service

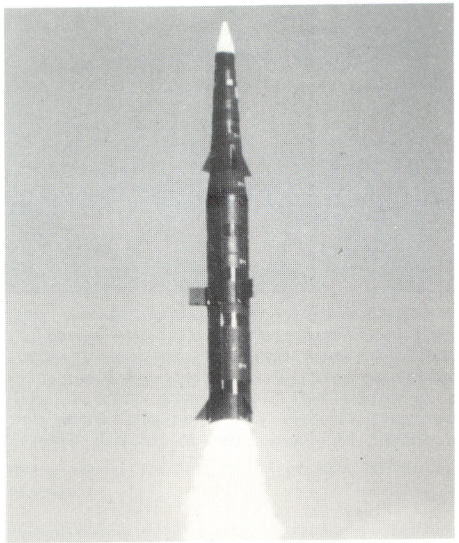
Martin Marietta's Orlando Division began development of Pershing in 1958, under the technical supervision of the US Army Missile Command, Redstone Arsenal, Alabama. Firing trials started in 1960 and achieved a higher success rate than those for any previous missile, with the result

Below: Pershing Ia missile system.

that the weapon was deployed in 1964, first with the US Army and later, also, with the West German forces.

Pershing is a selective-range weapon, able to provide rapid-reaction support for a theatre or general support for a field army. A typical battalion has four firing batteries, a headquarters battery and a service battery. In its original form, the complete weapon system was mounted on four XM-474 tracked vehicles. Under the Pershing Ia improvement programme (now the only version in service), these were replaced by wheeled vehicles based on the Ford M656 five-ton truck, carrying new support equipment. This includes an automatic azimuth reference system which allows Pershing to be launched from unsurveyed launching positions, and a sequential launch adapter which reduces the response time in a quick reaction role. Pershing Ia vehicles comprise the improved erector-launcher, an articulated truck and trailer carrying the missile and its warhead and capable of travel over roads or cross-country; a transporter for the improved programmer/test station and power station; the firing battery control centre truck; and the radio terminal set vehicle with an inflatable antenna. The equipment is air transportable by the Hercules transport aircraft. The MGM-31A (originally M-14) operational missile was unchanged by this improvement programme and deployment by the US Army and West German forces began in 1969. A training version is in service under the designation MTM-31B (originally M-19).

Currently in advanced development is the Pershing II. It is a modular improvement of the Pershing Ia, which replaces the present inertial guidance system and re-entry vehicle with a new and highly accurate terminally-guided and controlled re-entry vehicle. This accuracy allows lower yield nuclear warheads to be fitted while still destroying hardened targets. A single Pershing II missile could destroy some targets presently requiring attack by several Pershing Ias. The new missile system uses much of the existing equipment, including the Pershing Ia rocket motors and ground equipment.



Above: Pershing II.

Flight tests of the Radar Area Correlator guidance system have been conducted successfully and flight tests of the Pershing II missile have taken place.

A single-stage version of the Pershing missile is presently in the conceptual stage. It would allow two missiles to be carried on each launcher. Range would remain similar

Phoenix (AIM-54A)

USA

Long-range air-to-air missile. In production and service.

Prime contractor: Hughes Aircraft Company
Powered by: Rocketdyne Mk 47 Mod 0 solid-propellant rocket motor
Airframe: Cylindrical body with ogival nose. Long-chord cruciform wings and cruciform tail control surfaces
Guidance and Control: Hughes radar-homing guidance system. Control by tail surfaces
Warhead: High-explosive, with proximity fuse
Length: 13ft 0in (3.95m)
Body diameter: 1ft 3in (0.38m)
Wing span: 3ft 0in (0.91m)
Launch weight: 985lb (447kg)
Cruising speed: over Mach 5
Range: over 124 miles (200km)

Development and Service

Intended originally for the cancelled swing-wing F-111B tactical fighter, Phoenix offered such a great increase over the capability of earlier missiles that it was resurrected as primary armament of the US Navy's Grumman F-14 Tomcat. Maintenance and reliability are improved by the fact that the missile is made up of a number of self-contained sections, so that it can be handled as a complete unit or broken down for easy shipboard check-out and handling. In action, the target is located by the aircraft's Hughes AWG-9 weapon control system, which can lock on to the enemy in any kind of weather and launch Phoenix at optimum range. The pulse-Doppler radar of the AWG-9 enables it to 'look-down' and sort out a moving target from the ground clutter that obscures such targets in other systems. Its track-while-scan mode enables the fire control system to keep up to six missiles at a time on course while searching for further targets. The AWG-9 also incorporates an infra-red subsystem that provides an independent search and track sensor. Terminal homing is by an active radar system in the missile.

Above: F-14A Tomcat fighter with six Phoenix missiles.

Inert Phoenix missiles were first air-launched from an A-3A Skywarrior test aircraft in 1965. By March 1969, it was possible to intercept two Firebee target drones simultaneously with two missiles, while the targets were flying several miles apart. In August 1970, the 'look down' and track-while-scan features of the AWG-9 were tested in a launch against a Cougar jet fighter/drone flying many miles away and at lower altitude than the F-111B launch aircraft; the Cougar was destroyed. In June 1973 a Phoenix was launched from an F-14 Tomcat against a target drone, fitted with countermeasures, that was 126 miles (204km) away at the moment of launch. After climbing to 100,000ft (30,500m) during its trajectory the missile passed the drone within the lethal distance of the warhead fitted to operational rounds. Other tests proved, or so it was thought, the ability of the F-14/Phoenix to counter the threat of anti-shipping cruise missiles, to intercept multiple targets by simulaneous attacks with six missiles and to intercept high-flying Mach 3 fighters. However, according to a statement made by the General Accounting Office in 1979, the AIM-54A missile system is 'marginal at best against the current and postulated threat'. The first Phoenix production contract was placed by the US Navy in December 1970 and the first Phoenix-armed F-14 units became operational by 1974, deployed on USS *Enterprise*. By 1978, six US aircraft carriers were operating F-14s, when the number of AIM-54A missiles built had exceeded 1,700. The F-14s built for Iran are also armed with Phoenix. A second version of the missile, designated AIM-54C, is scheduled to enter initial low production of 60 missiles in FY 1980. This version will have increased ECCM capability and reliability, and will incorporate a new target detecting device, digitial electronics unit and autopilot, and other improvements.

Pluton and Super Pluton

France

Tactical nuclear surface-to-surface missile. In production and service.

Data: Pluton
Prime contractor: Aérospatiale, Division Engins Tactiques
Powered by: SEP Styx dual-thrust solid-propellant rocket motor
Airframe: Cylindrical body, with pointed ogival nose-cone and tail control surfaces
Guidance and Control: Simplified inertial guidance system based on SAGEM or SFENA stable platform linked to a computer. Control by electrically-actuated tail surfaces
Warhead: AN-51 tactical nuclear warhead, 25 kiloton yield, or 15 kiloton yield warhead.
Length: 25ft 1in (7.64m)
Body diameter: 2ft 1.5in (0.65m)
Fin span: 4ft 7.5in (1.41m)
Launch weight: 5,180lb (2,350kg)
Max range: 6.25-75 miles (10-120km)

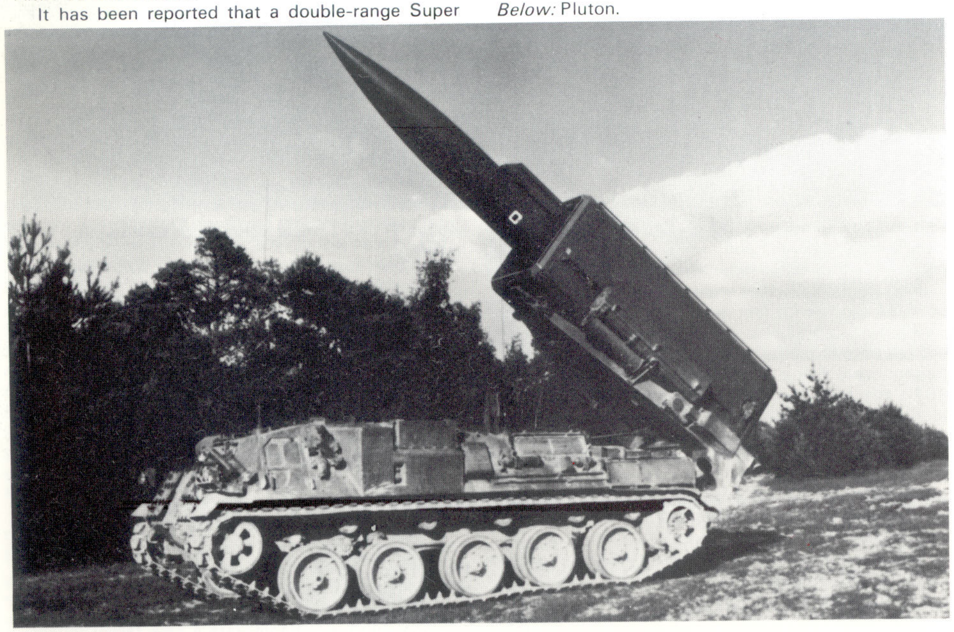
Development and Service

This mobile tactical weapon system was developed and produced to replace the Honest John bombardment missiles which equipped battalions of the French Army. Firing trials of full-scale Pluton test vehicles started in 1969. The versions launched from the summer of 1970 were fully representative of the operational missile, complete with guidance system but without a warhead. Development of the nuclear charge progressed as part of the French programme of atomic tests in the Pacific, and Pluton was first deployed to the 3rd Artillery Regiment in May 1974. Five regiments of the French Army deploy Pluton, totalling 30 missiles although the original plans were for 120 missiles.

Aérospatiale is responsible for the missile and its launching equipment, under the direction of the French Army's Division des Engins Tactiques. The missile and its warhead were supplied to operational units as two separate packages, with the missile container so designed that it serves also as the launch-tube when mounted on the tracked transporter-launcher. The latter is based on the AMX-30 tank chassis.

It has been reported that a double-range Super Pluton has been under consideration since 1977 as a Pluton successor. Super Pluton would have improved performance and accuracy and interchangeable nuclear and conventional warheads, the former for destruction of major targets and the latter for attacking armoured vehicle concentrations using submunitions.

Below: Pluton.



Polaris (UGM-27)

USA

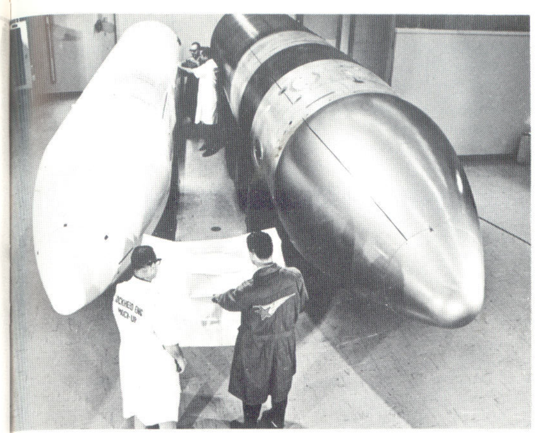
Underwater-to-surface or surface-to-surface ballistic missile. In service.

Data: UGM-27C Polaris A3
Prime contractor: Lockheed Missiles and Space Company
Powered by: First stage Aerojet-General solid propellant motor of 79,360lb (36,000kg) thrust Second stage Hercules Inc solid-propellant motor
Airframe: Two-stage missile. Cylindrical body with ogival nose-cone. First- and second-stage casings of glass-fibre. No fins or wings
Guidance and Control: Inertial guidance system developed under responsibility of Massachusetts Institute of Technology and manufactured by General Electric and Hughes. First stage control by gimballed nozzles, and second stage by a thrust-vector system utilising fluid injection
Warhead: Thermonuclear, in multiple re-entry vehicles (three of 200 kiloton yield each)
Length: 32ft 4in (9.85m)
Max body diameter: 4ft 6in (1.37m)
Launch weight: 35,000lb (15,850kg)
Max speed: 6,600mph (10,620km/h)
Max range: 2,875 miles (4,630km)

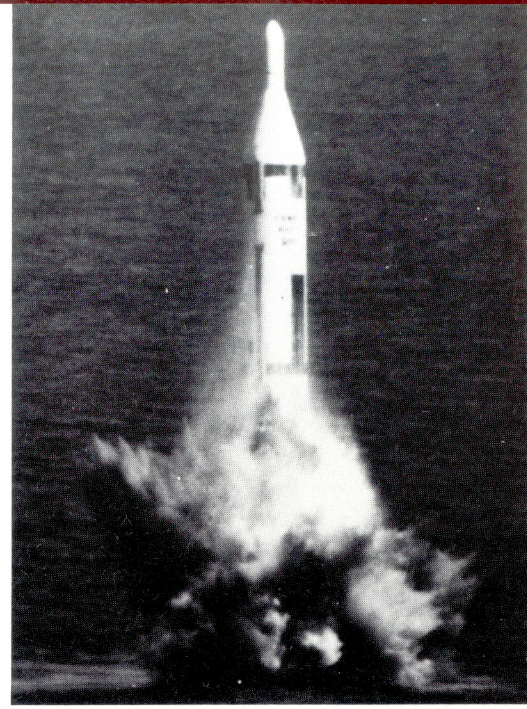
Development and Service

When the idea of launching a long-range ballistic missile from a submarine was first suggested, the problems seemed insurmountable. By 1956, advances in solid propellants, guidance systems and warheads offered the possibility of achieving a range comparable with that of land-based intermediate-range ballistic missiles then in production with a weapon only one-quarter their weight. Lockheed Missiles and Space Company (LMSC) began design studies for a missile that would go into a launch-tube on a specially-built submarine. The Autonetics Division of North American and Sperry started developing a Ship's Inertial Navigation System (SINS) that would establish the latitude and longitude of a submarine precisely and so ensure an accurate trajectory for any missile fired from it.

Firings of test missiles ashore and from the surface ship USS *Observation Island*, led to the first underwater launches in 1960. These culminated in the successful firing of two UGM-27A Polaris A1 missiles from a submerged submarine the USS *George Washington*, on 20 July of that year. This was a nuclear-powered ship which had been modified during construction to have a section containing 16 launch-tubes inserted amidships. The 40 missile submarines which followed for the US Navy, and four for the Royal Navy, were all specially built. The original UGM-27A was eventually superseded by the improved UGM-27B Polaris A2 (weight 30,000lb (13,600kg); range 1,700 miles (2,800km)) on 13 submarines, and the UGM-27C (data above) on 28 US and the four British ships. Polaris A3 became operational in 1964. Only 10 Polaris A3 (UGM-27C) submarines remain in US service as the seaborne strategic force in the Pacific. New British warheads are being developed for the Royal Navy Polaris missiles.



Above: Polaris A3 (left) with Poseidon C3.



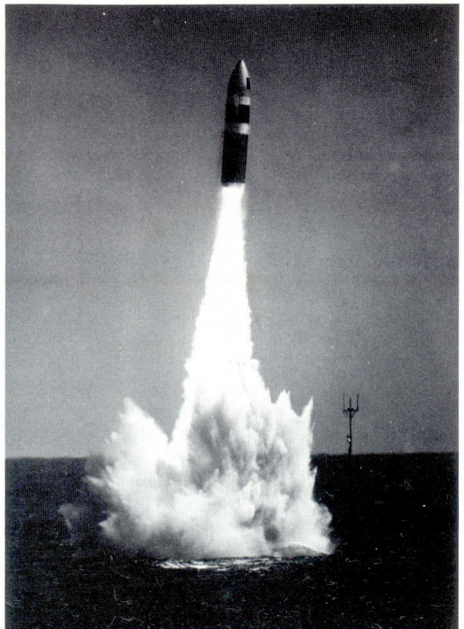
Right: Polaris A2 underwater launch.

Poseidon (UGM-73)

USA

Underwater-to-surface or surface-to-surface ballistic missile. In service.

Data: UGM-73A Poseidon C3
Prime contractor: Lockheed Missiles and Space Company
Powered by: First stage Hercules or Thiokol solid-propellant motor. Second stage Hercules solid-propellant motor
Airframe: Two-stage missile. Cylindrical body with ogival nose-cone. First- and second-stage casings of glass-fibre. No fins or wings
Guidance and Control: Inertial guidance system developed under responsibility of Massachusetts Institute of Technology and manufactured by General Electric and Raytheon. Thrust-vector control by one movable nozzle on each stage, actuated by gas generator
Warhead: Thermonuclear in multiple, independently-targetable re-entry vehicles



Right: Poseidon C3.

developed by LMSC and Atomic Energy Commission (10 or 14 of 50 kiloton yield each)
Length: 34ft 0in (10.36m)
Max body diameter: 6ft 2in (1.88m)
Launch weight: 65,000lb (29,480kg)
Max range: 2,875 miles (4,630km)

Development and Service

Having established the value of a submarine-launched strategic missile system with Polaris, the US Navy decided in 1965 to evolve the more formidable Poseidon to take advantage of new developments in missile technology. It was possible to pack larger missiles on board existing Polaris A3 submarines with only minor modification to the launch-tubes. This enabled Lockheed Missiles and Space Company (LMSC) to utilise larger motors and improved equipment and so offer double payload and twice the accuracy of Polaris. When added to the advantages that come from use of an MIRV warhead, these advances make Poseidon far more formidable than its predecessor.

Firing trials with Poseidon test rounds began on 16 August 1968. By June 1970 the initial batch of 20 missiles had all been launched, 17 of them from pads ashore and three from tubes on the surface ship USS *Observation Island*. Underwater launch trials began on 3 August 1970, when a Poseidon was fired from the USS *James Madison*, the first submarine that had been fitted with modified launch-tubes and improved navigation and fire control systems for the new weapon. Subsequent development was so rapid that the *James Madison* was declared operational in March 1971. All 31 submarines planned for modification are now operational, although 10 are to be modified further to carry the new Trident missile. Each Poseidon submarine carries 16 missiles.

Quail (ADM-20C)

USA

Air-launched decoy missile. In service.

Prime Contractor: McDonnell Aircraft Corporation
Powered by: General Electric J85-GE-7 turbojet of 2,450lb (1,112kg) st
Airframe: Aeroplane configuration. Rectangular body, with rounded nose. Short, high-set, folding cropped-delta wings at rear, each with a vertical tail-fin at mid-span and another projecting downward from the wingtip. Ram air-intake on each side of body
Guidance and Control: McDonnell autopilot
Warhead: None, but self-destruct device is fitted to prevent missile being recovered by enemy
Length: 12ft 10in (3.91m)
Launch weight: 1,200lb (545kg)
Cruising speed: Mach 0.9
Range: over 250 miles (400km)

Development and Service

Until the AGM-86A air-launched cruise missile (ALCM) is ready for service, Quail will remain unique in USAF service. Its sole task is to fly pre-planned 'patterns' in enemy airspace, so that it will be picked up on early warning, missile and interceptor fighter radars and confuse the defences. This is made possible by one of several electronic devices packed into Quail's glassfibre body, which ensures that the tiny decoy produces the same 'blip' on a radar screen as the huge B-52 Stratofortress bomber from which it is air-launched.

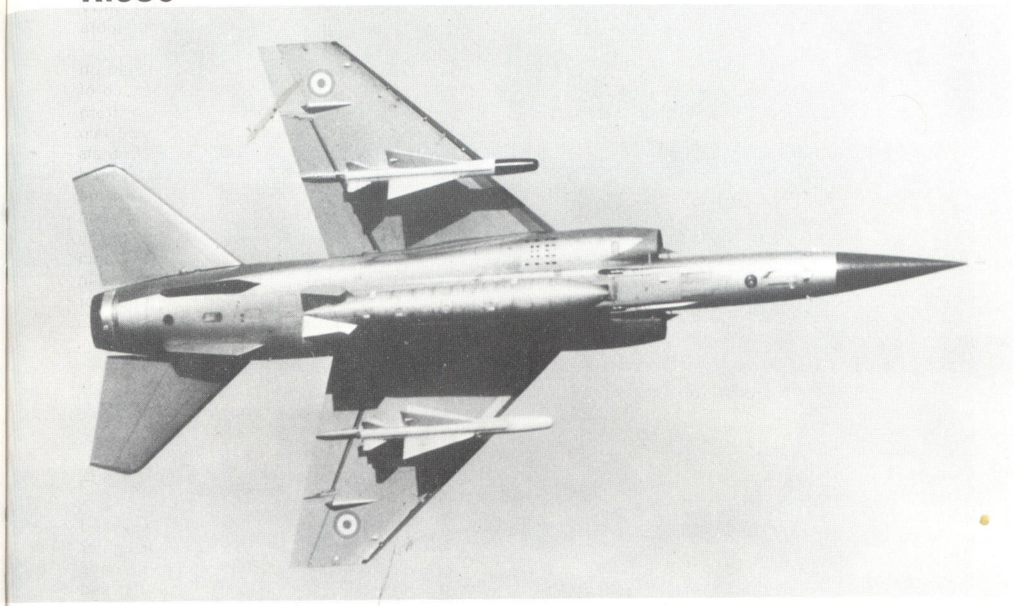
McDonnell began developing Quail, as the XGAM-72, in 1955. By June 1960, a B-52 was able to drop three Quails in rapid succession in an operational-type pattern over Eglin AFB. Before the end of that year, the first of the improved production-type ADM-20B Quails showed its paces in pre-programmed multi-flight tests in the same altitude and speed ranges as the B-52. Deployment to Strategic Air Command bases was completed between March 1961 and January 1962.

Four Quails can be packed into a small launch package, with their wing and tail surfaces folded, for stowage in the bomb-bay of the B-52. Just before launch the engine is started and the wings and fins extend. The current operational version is designated ADM-20C.

U.S. AIR FORCE

R.530

France



Above: Mirage F1 with underwing R.530s.

Air-to-air missile. In production and service.

Prime contractor: SA Matra
Powered by: Hotchkiss-Brandt two-stage solid-propellant rocket motor of 18,740lb (8,500kg) st
Airframe: Cylindrical body, with slightly tapering and rounded nose. Cruciform delta wings, of which two have ailerons, indexed in line with cruciform tail control surfaces. Glass-tipped nose on infra-red version
Guidance and Control: Alternative AD-26 semi-active radar or infra-red homing. Control via ailerons and movable tail surfaces
Warhead: Hotchkiss-Brandt, weighing 60lb (27kg), with proximity fuse
Length: 10ft 9.25in (3.28m)
Body diameter: 10.25in (0.26m)
Wing span: 3ft 7.25in (1.10in)
Launch weight: 430lb (195kg)
Max speed: Mach 2.7
Max range: 11 miles (18km)

Development and Service

More than 3,000 R.530 air-to-air missiles have been built, and these formidable weapons are carried as standard armament under the fuselage of Mirage III interceptors and under the wings of Mirage F1s of the French Air Force. They have also been exported to 14 nations, including Argentina, Australia, Brazil, Colombia, Pakistan, Venezuela and South Africa, and are carried on each side of the front fuselage of the French Navy's F-8E(FN) Crusaders.

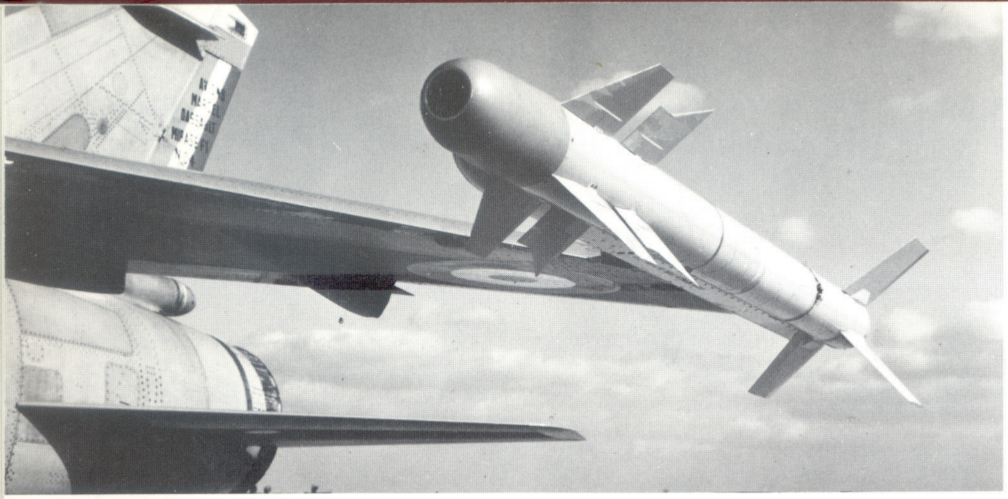
The R.530 is an all-weather missile, suitable for use at heights from sea level to 69,000ft (21,000m). The alternative types of homing head are sensitive enough to pick up the target during attack from any direction; unlike some infra-red missiles which must be launched from behind the target in order to lock on to the heat from its jet efflux. The latest anti-jamming ECM devices are fitted to the AD-26 radar head.

R.550 Magic

France

Short/medium-range air-to-air 'dogfight' missile. In production and service.

Prime contractor: SA Matra
Powered by: SNPE Romeo solid-propellant rocket motor
Airframe: Slim cylindrical body with rounded nose. 'Double-canard' configuration, with movable foreplane control surfaces immediately behind and indexed in line with cruciform fixed wings. Cruciform tail-fins also indexed in line
Guidance and Control: Infra-red homing system. Control by foreplanes



Warhead: 13.2lb (6kg) of explosive with impact and proximity fuses
Length: 9ft 0in (2.74m)
Body diameter: 6in (0.157m)
Wing span: 1ft 6.5in (0.47m)
Launch weight: 194lb (88kg)
Cruising speed: over Mach 2
Range limits: 985ft-4.35 miles (300m-7km)

Development and Service

This is Matra's answer to the need for a close-range, fast-manoeuvring 'dogfight' missile, emphasised by the failure of air-launched missiles to hit MiGs during air combats in Vietnam. Its development was started as a private venture in 1967, but has continued under French Air Force sponsorship since 1969. The R.550 can use the same aircraft launcher as the Sidewinder, which it is intended to replace.

The first air-launch of the missile with guidance equipment was carried out on 11 January 1972, at Landes Test Centre. Test and evaluation of production missiles began in 1974. Orders have been placed by 12 countries for a total of 5,000 operational and training missiles. The R.550 Magic has been in series production since March 1975 for delivery to customers. By the end of 1978, the 3,200th Magic had been built and production continues at 100 per month.

Magic has been adopted to equip the Mirage III, Mirage 5, Mirage F1 and Crusader, and is at present being adapted for the Jaguar, Super Etendard, Macchi MB326K and Alpha Jet. It will also arm the Delta 2000.

The R550 Magic is stated by its manufacturers to be the only air superiority missile operational at present capable of intercepting and destroying existing fighters even when they are manoeuvring at their maximum g capabilities.

Rapier

UK

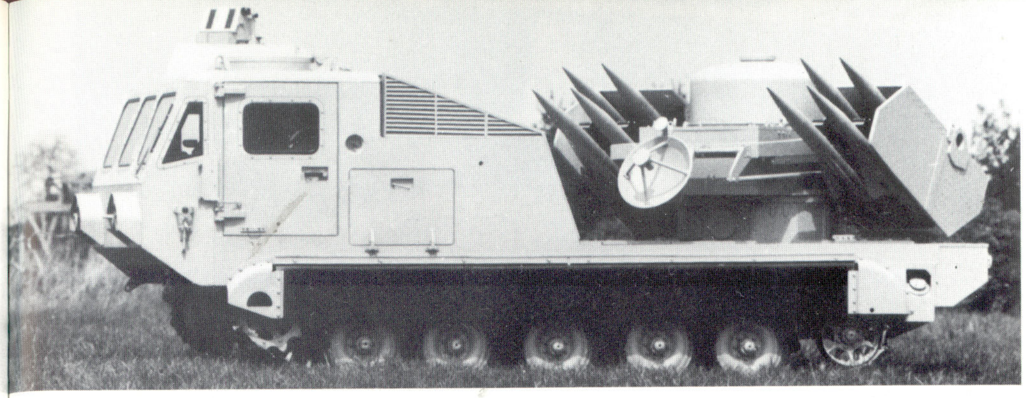
Surface-to-air close-range missile. In production and service.

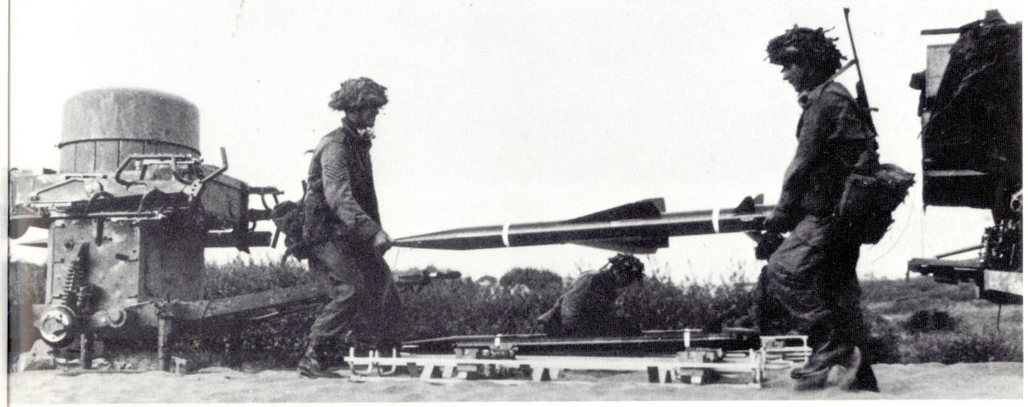
Prime contractor: British Aerospace Dynamics Group
Powered by: IMI two-stage solid-propellant rocket motor
Airframe: Cylindrical body, with cruciform cropped-delta wings mounted mid-way between the pointed conical nose and the cruciform tail-fins
Guidance and Control: Radio command guidance system, along line-of-sight to target. Add-on radar tracking system for all-weather operation also in full production. Control by movable tail surfaces
Warhead: High-explosive, with impact fuse
Length: 7ft 3in (2.2m)
Body diameter: 5in (0.13m)
Wing span: 1ft 3in (0.38m)
Weight: approx 88lb (40kg)
Max speed: over Mach 2
Range: Can operate from ground level up to at least 10,000ft (3,660m)

Development and Service

Known originally as the ET.316 low-level anti-aircraft guided weapon system, Rapier was developed initially under a contract awarded in September 1964. Progress was so rapid that production of the missile for the British Army and RAF Regiment was able to begin by mid-1967. Operational deployment by both services was under way by 1971. Large export orders for Rapier have been received from Australia, Zambia, the Sultanate of Oman and Abu Dhabi.

Rapier is a quick-reaction weapon, designed to achieve a high kill probability when launched against helicopters, subsonic and supersonic fixed-wing aircraft at all heights from ground level to above 3,000m. The system can use either an optical or radar mode of operation. The main system elements are a launcher containing the surveillance radar, an optical tracker and two power units. Once the launcher has been loaded by two members of the three/five-man detachment (seven men for 'blindfire' operations), it can be left unattended and the system can be operated by one man at the optical tracker. When the surveillance radar in the launcher detects a target, an IFF interrogator determines if it is hostile. If it is, the launcher and tracker are aligned automatically in the direction of the target. In the optical system, the operator acquires the target in elevation and then tracks it by means of a joystick, with the launcher following the tracker as he does so. When the target is within range, as assessed by a computer, the operator is informed and fires a Rapier missile. Flares on the missile are followed by a TV camera in the tracker, which measures deviations from the sightline. The computer uses these data to correct the missile's trajectory and keep it on course to the target.





Top: Tracked Rapier system.

Above: Loading Rapier missiles on to the four-round launcher.

For operation at night, or in bad visibility, a 'blindfire' radar tracker is used to automatically perform the functions of the optical tracker for target tracking and missile-to-sightline error measurement. The operator remains in control of the engagement, and can choose between an optical or radar-directed engagement up to missile launch.

The launch unit can be towed by a Land-Rover or similar light vehicle, carrying in the back the missiles and optical tracker. If a 'blindfire' tracker is needed, a second vehicle is required. The Rapier system is air transportable.

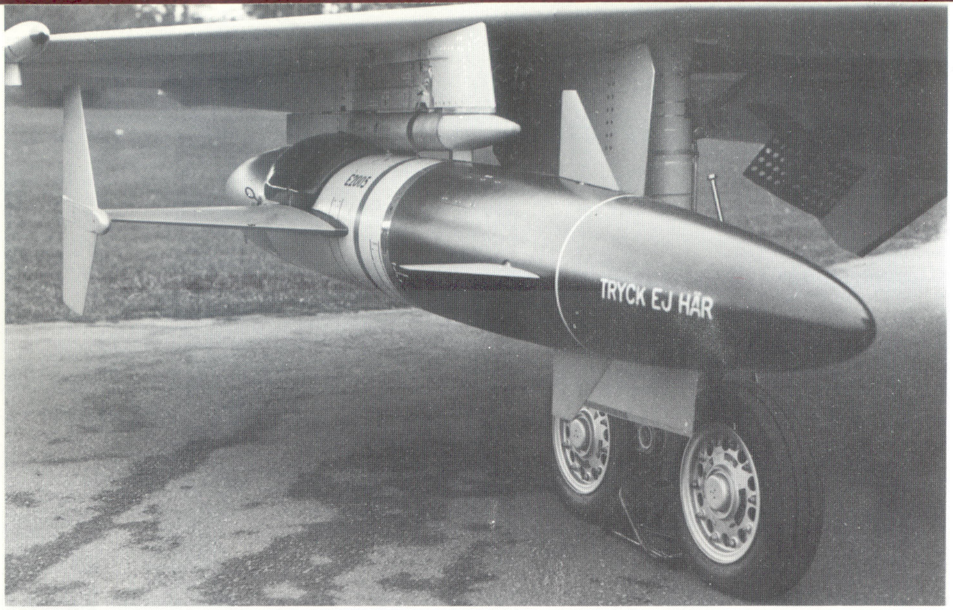
Latest version is the Tracked Rapier system based on an M-548 or similar vehicle, which was ordered by Iran prior to the change of government.

RB04

Sweden

Air-to-surface tactical missile. In service

Data: RB04E
Prime contractor: Saab-Scania Aktiebolag
Powered by: IMI solid-propellant rocket motor
Airframe: Body of circular section, tapering in a smooth curve towards nose and tail. Mid-set rear-mounted wings, each with a trailing-edge aileron and fixed end-plate fin. Cruciform cropped-delta control surfaces at front of missile
Guidance and Control: Philips (Sweden) active-seeker head. Control by ailerons and foreplanes
Warhead: High-explosive type, weighing 660lb (300kg), with proximity fuse
Length: 14ft 8in (4.47m)



Above: RB04E.

Max body diameter: 1ft 7.75in (0.50m)
Wing span: 6ft 5.5in (1.97m)
Launch weight: 1,358lb (616kg)
Max speed: High subsonic
Range: over 12.5miles (20km)

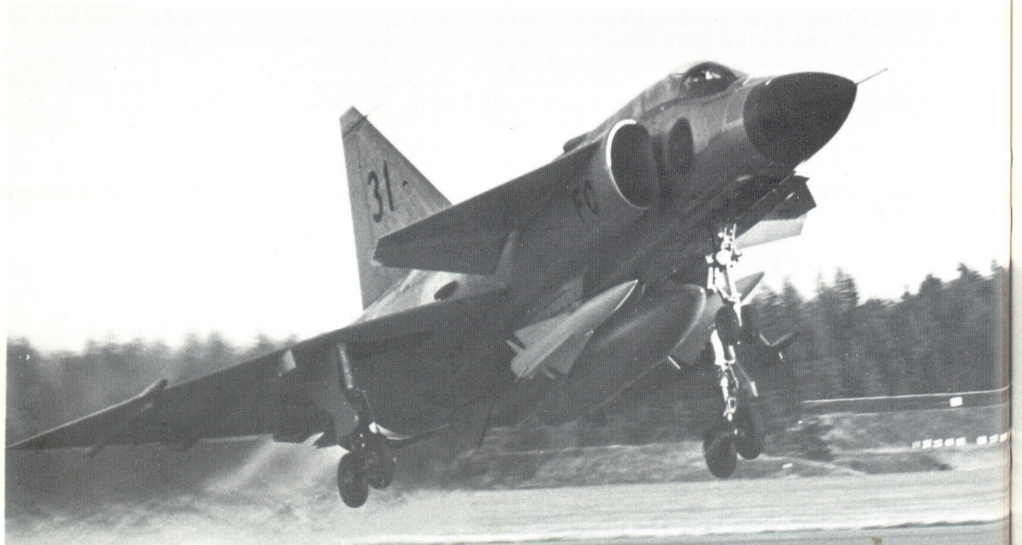
Development and Service

This formidable all-weather attack missile was evolved originally by the Swedish Guided Weapons Directorate (Robotavdelningen), to meet a 1949 requirement for an anti-shipping weapon. The first complete RB04 was launched from a Saab J29 fighter on 11 February 1955; four years later the missile became standard armament on the Saab A 32A Lansens which equip attack wings of the Swedish Air Force. Performance is subsonic, but the RB04 has proved so effective that it also equips the Saab AJ 37 Viggen Mach 2 attack fighter. This aircraft carries a third RB04 under its fuselage, in addition to the usual two on underwing mountings.

Current version of the missile on the A 32A is the RB04D, with higher performance than the earlier standard RB04C. The 'D' became operational in 1972 and has been followed by the RB04E, with revised structure and guidance to improve reliability and accuracy. Saab-Scania was prime contractor for the RB04E, which is now out of production. It can be launched at between Mach 0.4 and near-sonic speeds. It then flies a preprogrammed descent to low level for attack.

RB05A

Sweden



Tactical air-to-surface missile. In service

Prime contractor: Saab-Scania Aktiebolag
Powered by: Volvo Flygmotor VR-35 storable liquid-propellant rocket motor
Airframe: Cylindrical body with long ogival nose. Long-chord cruciform delta wings, indexed in line with cruciform tail control surfaces
Guidance and Control: Command guidance, via pilot-operated joystick, with aid of tracking flare on missile. Control via tail surfaces
Warhead: High-explosive, with proximity fuse
Length: 11ft 10in (3.60m)
Body diameter: 1ft 0in (0.30m)
Wing span: 2ft 8in (0.80m)
Launch weight: 675lb (305kg)
Max speed: Supersonic
Range: 5.5 miles (9km)

Bottom left: RB05As carried by a Viggen.

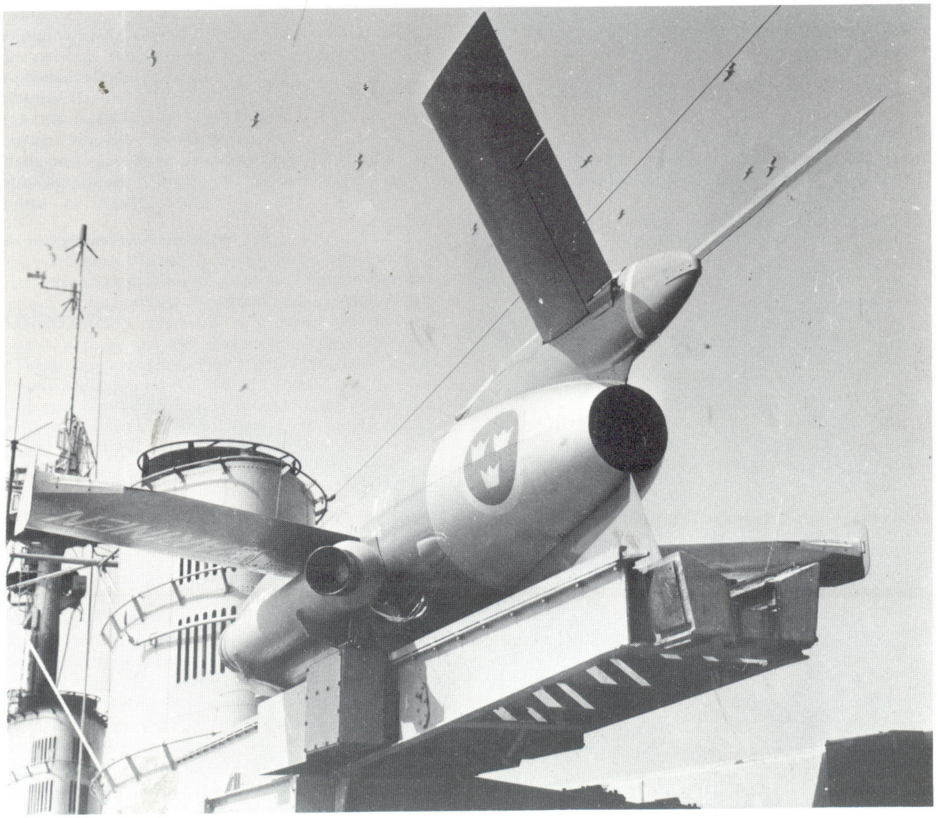
Development and Service

In its initial form, this weapon lacks the all-weather capability of the RB04, being manually-guided. However, the precision of the guidance system and high degree of manoeuvrability of the missile make it possible to attack sea or land targets situated a considerable distance to either side of the launch aircraft's course, and Saab claims that the RB05A can also be used in an air-to-air role. The microwave radio link over which the pilot's command signals are transmitted is said to be highly resistant to jamming and to permit full control of the missile at low altitudes over all kinds of terrain. The pilot simply guides the missile so that a tracking flare on its rear end remains aligned on the target.

Development of the RB05A began in 1960, under the designation Saab 305A. An initial £14.5million production contract was placed in November 1970, to arm the AJ 37 Viggen and the SK 60B/C versions of the lightweight Saab-105 in Swedish Air Force service. However, the missile went out of production in 1978.

RB08A

Sweden



Surface-to-surface or ship-to-ship missile. In service.

Prime contractor: Saab-Scania Aktiebolag
Powered by: Turboméca Marboré IID turbojet. Two solid-propellant booster rockets power the launch carriage
Airframe: Circular-section body which tapers towards nose and tail. Long tapered radome above nose air intake. Mid-set folding wings are swept at 30 degrees and fitted with end-plates and spoilers. Vee-type tailplane and elevators are supplemented by ventral fin, all swept at 30 degrees
Guidance and Control: Autopilot control, following directional firing. Terminal homing. Aerodynamic control by spoilers and elevators
Warhead: High-explosive
Length: 18ft 9.25in (5.72m)
Max body diameter: 2ft 2in (0.66m)
Wing span: 9ft 10.5 in (3.01m)
Launch weight: 2,678lb (1,215kg) (inc booster)
Performance: Secret

Development and Service

This missile had its origin in the French CT.20 target drone, designed and manufactured by Nord-Aviation. The French company evolved combat versions known as the SM.20 and MM.20 for surface-to-water (so-mer) and water-to-water (mer-mer) use respectively, and stated that these could carry a 550lb (250kg) warhead over a range of 155 miles (250km). The Royal Swedish Navy awarded Saab a contract to develop a similar operational version of the CT.20 in 1959, followed by a production contract in 1965. Deliveries were completed by 1970, and the RB08A is now deployed with coastal defence batteries and on board *Södermanland* and *Halland* classes of destroyers of the Royal Swedish Navy. In the latter case, the missiles are stored below deck and transferred by ramp to the launcher when required for action. The Swedish-designed warhead is claimed to be highly-effective against invasion from the sea.

RB83

Sweden

Air-to-surface missile. Under development.

Guidance and Control: Infra-red homing

Development and Service

This missile is being developed to arm the Saab B3LA light combat aircraft/jet trainer when it enters service in the 1980s.

RBS 70

Sweden

RBS 70 launch.

Portable surface-to-air missile system. In production and service.

Prime contractor: AB Bofors
Guidance and Control: Optical beam-rider, via laser beam
Container length: 5ft 3in (1.58m)
Container diameter: 6in (0.15m)
Total weight of firing unit: approx 176lb (80kg)
Missile weight in container: 47.5lb (21.5kg)
Range: 1.8-3.1 miles (3-5km)

Development and Service

Development started in 1969 and was completed, after three series of firing tests, in 1974. The RBS 70 system can be used against fighter-bombers and helicopters. Its main characteristics include good resistance to jamming, short reaction time, and ability to engage at coarse angles. The system can utilise precision target location data from a search radar, and IFF equipment can be connected. The firing can be carried out by one man. The system is operational with the Swedish Army and NATO and has been ordered by several other countries.

Redeye (FIM-43A)

USA

Shoulder-fired surface-to-air missile. In service.

Prime contractor: General Dynamics Corporation, Electro Dynamic Division
Powered by: Atlantic Research Corporation M115 dual-thrust solid-propellant rocket motor
Airframe: Cylindrical body with flip-out cruciform tail-fins and nose vanes. Glass nose over infra-red seeker
Guidance and Control: Initial optical aiming, with infra-red terminal homing. Control via nose vanes
Warhead: High-explosive
Length: 4ft 0in (1.22m)
Body diameter: 2.75in (0.07m)
Launch weight: 18lb (8.2kg)
Weight of complete system: 29lb (13.15kg)
Cruising speed: Supersonic
Range: 11,150ft (3,400m)

Development and Service

After satisfying the US Army as to the feasibility of such a weapon system, the former Convair-Pomona division (later Pomona operation of Electro Dynamic Division of GD) received a contract to develop Redeye in August 1959. Production began in 1964 and eventually reached the rate of more than 1,000 missiles per month for the US Army and Marine Corps. Each armoured, artillery and infantry battalion of the Army has a Redeye section composed of one officer, a sergeant and four to six two-man firing teams. Redeye is also a standard weapon in the Australian, Danish (known as Hamlet), West German (known as FLF-1 and Fliegerfaust), Swedish (designated RB69) Armies. Production was completed in the 1970 fiscal year.

Extremely compact, the weapon system consists simply of a sealed launch-tube, containing the missile, and a self-contained optical sighting/firing package attached to the tube. This makes it easily transportable by one man in a combat area, or in rough country, and it is effective against attacking aircraft at altitudes and ranges commensurate with the defence of Army field positions and Marine Corps amphibious operations. When the operator sights an enemy aircraft, he tracks it by means of the sight and energises the missile guidance system. A buzzer informs him when the missile is ready to fire. The boost charge propels the missile out of the launcher. When Redeye has travelled far enough to protect the operator from blast effects (about 20ft; 6m), the sustainer fires and propels the missile to the target.

Red Top

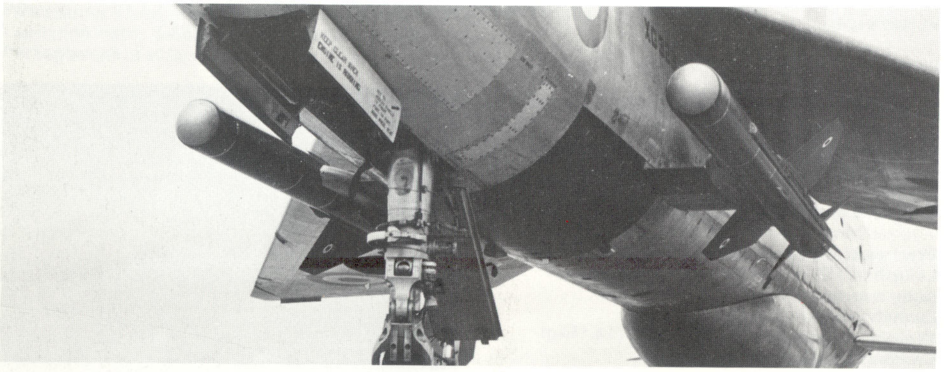
UK

Air-to-air missile. In service.

Prime contractor: British Aerospace Dynamics Group
Powered by: Solid-propellant rocket motor
Airframe: Cylindrical body, with fixed cruciform wings indexed in line with cruciform triangular tail control surfaces. Hemispherical glass nose
Guidance and Control: Infra-red homing guidance system. Control by tail surfaces
Warhead: High-explosive, weighing 68lb (31kg)
Length: 10ft 9in (3.27m)
Body diameter: 8.75in (0.222m)
Wing span: 2ft 11.75in (0.91m)
Weight: Secret
Cruising speed: Mach 3
Max range: 7.4 miles (12km)

Development and Service

Red Top was developed originally, as Firestreak Mk IV, to overcome the limitations of the earlier pursuit-course missile. Its much improved infra-red guidance system enables the pilot of the launch aircraft to fire it against the target from any direction, even dead ahead, and the larger wings and tail surfaces offer improved manoeuvrability at all altitudes. Performance is increased by use of a more powerful rocket motor, and the warhead is also heavier than that of Firestreak. Red Top is interchangeable with Firestreak on Lightning interceptors of the RAF.



Roland

France/Germany

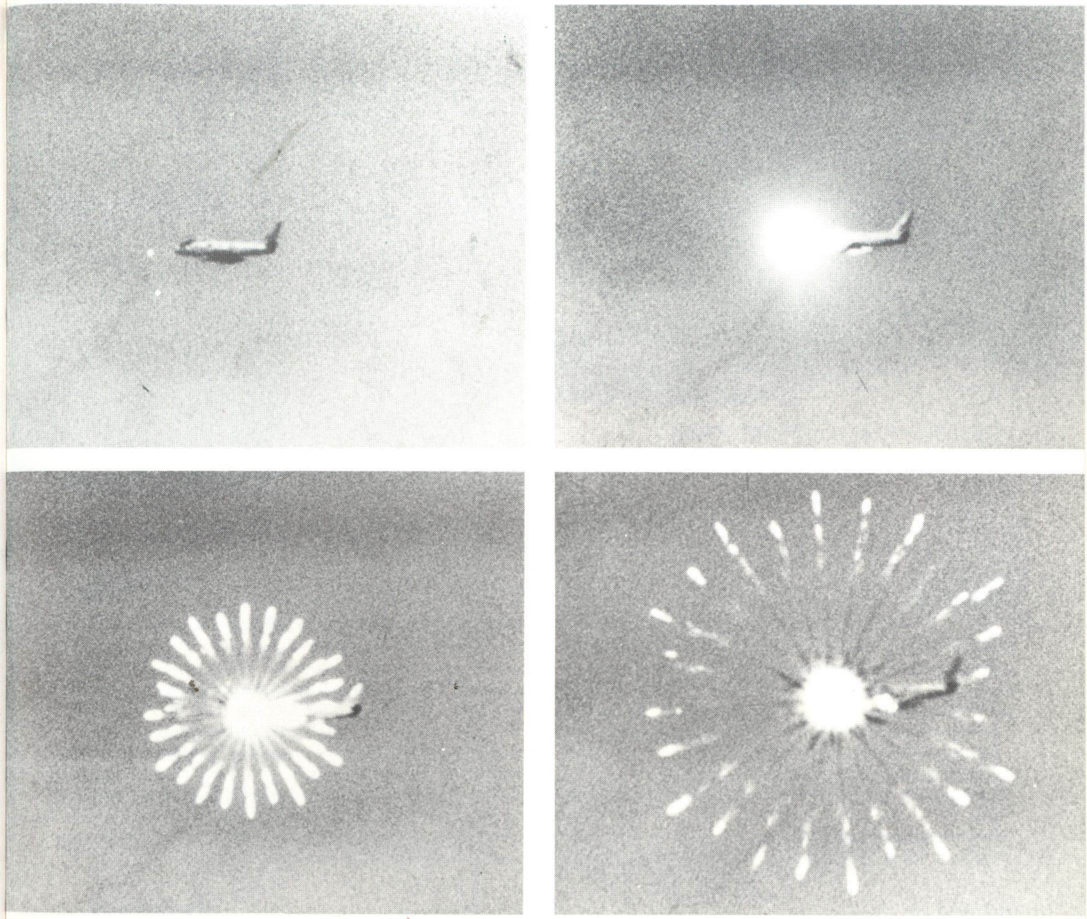
Close-range surface-to-air missile. In production and service

Prime contractor: Euromissile (Aérospatiale Division Engins Tactiques/Messerschmitt-Bölkow-Blohm GmbH)
Powered by: Two stage solid-propellant rocket motor
Airframe: Slim cylindrical body with pointed ogival nose. Fixed cruciform foreplanes indexed in line with hinged cruciform delta wings which extend as the missile leaves the launch-tube
Guidance and Control: Radio command guidance by optical aiming/infra-red tracking system. Control by vanes in sustainer motor exhaust
Warhead: High-explosive with proximity fuse
Length: 7ft 10.5in (2.40m)
Body diameter: 6.3in (0.16m)
Wing span: 1ft 7.75in (0.50m)
Launch weight: 139lb (63kg)
Cruising speed: Mach 1.6
Range limits: 1,650-20,670ft (500-6,300m)

Development and Service

Tube-launched from medium-size armoured vehicles or semi-mobile installations, Roland is intended to provide battlefield defence against helicopters and low-flying fixed-wing aircraft flying at speeds up to Mach 1.3. It is one of a family of tactical missiles developed jointly by Aérospatiale and MBB for the French and German Armies, and firing trials have been underway since 1968. In December 1970 four Rolands were launched against a CT.20 target drone; all achieved successful interceptions and the last one, fitted with a warhead, destroyed it.

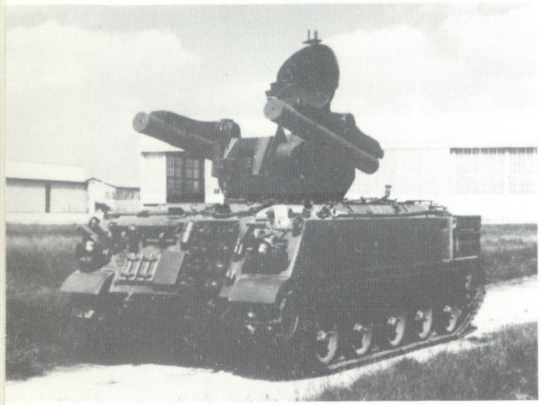
In its initial form, as Roland I, the weapon is fired from a twin-launcher, which can be carried with its pulse-Doppler surveillance and search radar on the French AMX-30R and the German SPZ Marder combat vehicles. The missile's shipping container serves also as launcher and is loaded by a hydraulic system which recharges the launch turret each time a missile has been fired. After a target has been located in azimuth by the radar and IFF identification has been performed, the operator acquires it in elevation and tracks it optically. The missile is then fired. The periscopic sight is linked to an infra-red missile tracking system and a computer, which processes the data fed into it and transmits command signals to the missile to keep it on the line-of-sight course to the target.

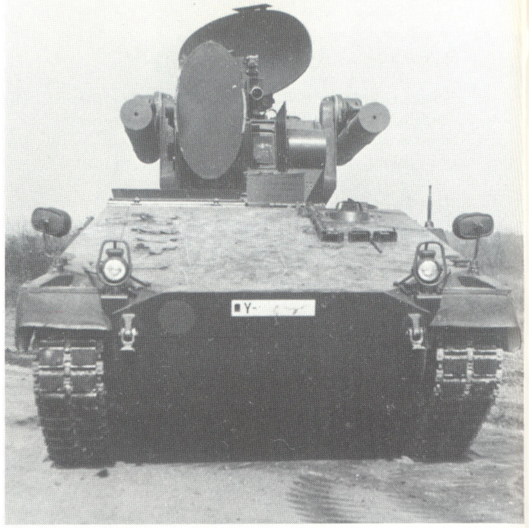


Above: A sequence of photographs showing the first live firing of a US Roland missile against a QF-86 target drone (see p148 for entry on US Roland).

Roland II began its development phase in 1968. The French Army originally ordered 12 modified, all-weather Roland II systems. In Roland II it is the tracking radar which searches in elevation and locks on to the target, eliminating the need for an optical tracker. The radar antenna follows the target and carries an infra-red sensor which gathers the missile after launch. A second channel in the radar tracks the missile, to which steering commands are transmitted automatically. Other customers for Roland II include the German Army, US Army, Norwegian Army (32 fire units and 600 missiles) and Brazilian Army. The French Army is expected to receive 96 Roland I fire units and 4,300 missiles and 104 Roland II fire units and 4,450 missiles; the German Army will receive 340 launchers and 12,100 missiles. The US Army missiles will be produced under licence by Hughes Aircraft Company and will be mounted on the M-109 tracked vehicle (see US Roland).

The first live firing of a production Roland took place in March 1976. The French Army received its initial operational Roland I system in April 1977. Germany received its first operational Roland II in October of the same year.





Above: Roland I on an AMX-30R chassis.

Right: Roland II on an SPZ Marder combat vehicle.

Sabre

UK

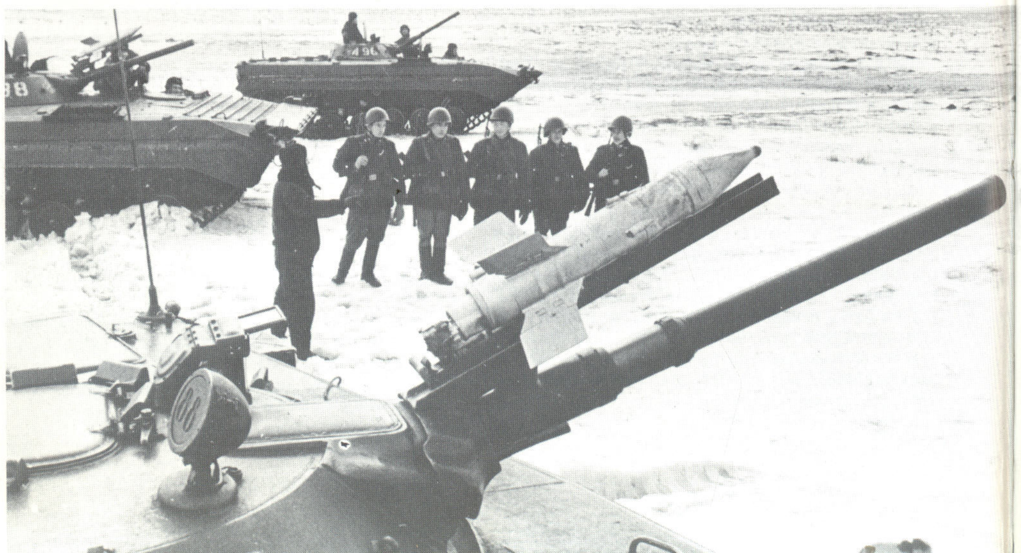
Air-to-surface anti-tank missile. Under development.

Airframe: Based on the Rapier missile
Guidance and Control: Probably laser homing
Launch weight: approx 120lb (55kg)
Cruising speed: over Mach 2
Range: approx 3.1-3.7 miles (5-6km) at low altitude

Development and Service
Sabre is being developed to a British requirement for an all-weather lightweight anti-tank missile, which could arm several different British and foreign aircraft, including the BAe Hawk advanced training and close support aircraft. Details were first released in 1978. Based on the Rapier surface-to-air missile, Sabre is expected to use a Martin Marietta laser seeker in association with the Pave Spike target designation pod or Thomson-CSF Atlis pod. It is said to be capable of penetrating the latest Soviet T-72 tank, with a likely kill probability of about 80%. It could also have air-to-air capability.

Sagger (AT-3)

USSR



Anti-tank missile. In service.

Powered by: Solid-propellant rocket motor
Airframe: Short cylindrical body, with conical nose. Rear-mounted cruciform wings are swept near body of missile but unswept outboard. Wings fold for storage and transport
Guidance and Control: Wire guidance
Warhead: Hollow charge
Length: 2ft 10in (0.86m)
Body diameter: 5in (0.12m)
Wing span: 1ft 6in (0.46m)
Launch weight: 24.9lb (11.3kg)
Range: 1,640-9,840ft (500-3,000m)

Development and Service
'Sagger' is one of the standard types of small anti-tank missiles serving with the armed forces of Russia, Algeria, Angola, Afghanistan, Ethiopia, Egypt, Iraq, Libya, Syria, Mozambique, Uganda, Vietnam and Yugoslavia. It was first displayed publicly in May 1965. It was shown then on a six-round launcher mounted on the BRDM-1 armoured amphibious vehicle which is used also as a carrier for 'Snapper' and 'Swatter'. The installation is interesting, as the launcher is protected during transport by an armoured cover plate that encloses it within the vehicle. When the launcher is elevated for action, the cover plate remains in place above the launcher, affording continued protection. A single 'Sagger' is carried on a rail launcher above the 76mm gun on the BMP eight-man armoured personnel carrier, first seen in 1967, and the missile can be carried by the BMD-1 light tank (one launcher), BRDM-2/BTR40PB vehicle (six launchers) and other Warsaw Pact vehicles. 'Sagger' can also be ground-launched by two-man teams, using a portable system.

Salish

USSR

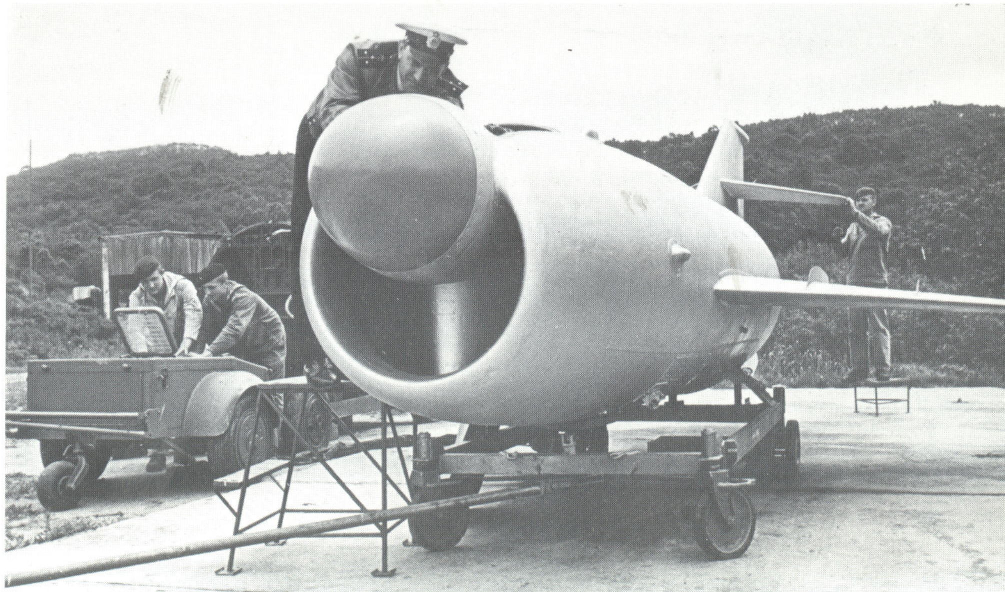
Surface-to-surface cruise missile. In service.

Powered by: Turbojet motor. Also seen with JATO booster
Airframe: Similar to 'Samlet'
Guidance and Control: Probably semi-active homing
Range: approx 62 miles (100km)

Development and Service
Salish is a ramp-launched cruise missile, older in appearance than Samlet. It is thought to carry semi-active homing equipment in its radome, above the nose air-intake. It may have been derived from the air-to-surface 'Kennel'.

Samlet

USSR



Surface-to-surface cruise missile. In service.

Powered by: Turbojet engine. JATO booster used at launching
Airframe: Circular-section metal body, with hemispherical radome above chin-type air-intake at nose. Mid-mounted sweptback wings, each with two fences on top surface. Swept horizontal tail surfaces mounted mid-way up tail-fin
Guidance and Control: Probably beam-riding/command guidance with terminal semi-active radar homing. Aerodynamic control surfaces
Warhead: High-explosive
Length: approx 23ft 0in (7.0m)
Wing span: 16ft 0in (4.9m)
Weight: approx 6,615lb (3,000kg)
Cruising speed: approx Mach 0.8
Max range: 63-126 miles (100-200km)

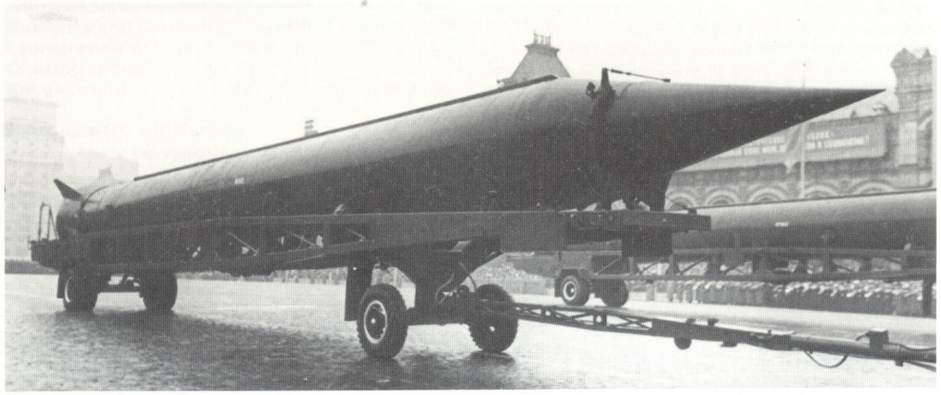
Development and Service
This subsonic cruise missile is a surface-to-surface version of the air-to-surface 'Kennel'. It differs little from the air-launched weapon and is used primarily for coastal defence by the armed forces of the Soviet Union, Poland, Egypt and Cuba.

SA-N-4 USSR

Surface-to-air missile. In service.

Development and Service
Little is known about this close-range weapon system although at least 68 SA-N-4 installations are operational on seven classes of Soviet ships including Sverdlov and Kara class cruisers, Kiev aircraft carriers, Krivak destroyers, Nanuchka and Grisha corvettes and Koni frigates. The retractable twin-round 'pop-up' launcher is housed inside a bin on the deck. The missiles are thought to be the same as those used in the land-mobile 'Gecko' (SA-8) system. The fire control radar system carries the NATO reporting name 'Pop Group'.

Sandal (SS-4) USSR



Surface-to-surface medium-range ballistic missile. In service.

Powered by: One liquid-propellant engine. No booster
Airframe: Cylindrical metal body, with flared skirt around nozzle and small cruciform tail-fins. Pointed conical nose-cone
Guidance and Control: Inertial guidance system. Control by elevators in trailing-edges of tail-fins and vanes operating in rocket efflux
Warhead: Alternative nuclear (one MT) or high-explosive
Length: 68ft 0in (20.8m)
Max body diameter: 5ft 3in (1.60m)
Launch weight: approx 60,000lb (27,200kg)
Max speed: 4,300mph (6,900km/h)
Max range: approx 1,100 miles (1,750km)

Development and Service
After early postwar firing trials with captured German V-2 bombardment rockets, the Soviet Union evolved an improved version which became known to NATO forces as the SS-3 'Shyster'. This had a longer, cylindrical body, permitting increased propellant tankage, and was first displayed in a Moscow parade in November 1957. Its transporter was hauled by a tracked vehicle carrying the launch crew.

In 1961, a further-improved version was shown for the first time. Known in the west as the SS-4 'Sandal', this is longer, giving increased propellant capacity and range. 'Sandal' was first deployed in 1959. It can be identified by the flared skirt over its rocket nozzle, and smaller tail-fins. 'Sandal's' transporter is hauled by the same kind of vehicle as that of 'Shyster', the complete missile system being completed by other tractor/trailer units carrying ground support equipment and propellants.

'Sandal' replaced 'Shyster' as Russia's standard MRBM and has been used widely, in modified forms, as a satellite launch vehicle. Between 400 and 450 are thought to remain operational, of which a reasonable number are directed at China and Japan and the remainder at targets in Western Europe. Discovery by US reconnaissance aircraft of an attempted deployment of 'Sandals' in Cuba led to the Soviet/American confrontation in 1962 and eventual withdrawal of the missiles. 'Sandals' are being replaced by SS-20s with MIRVed warheads (qv).

Savage (SS-13) USSR

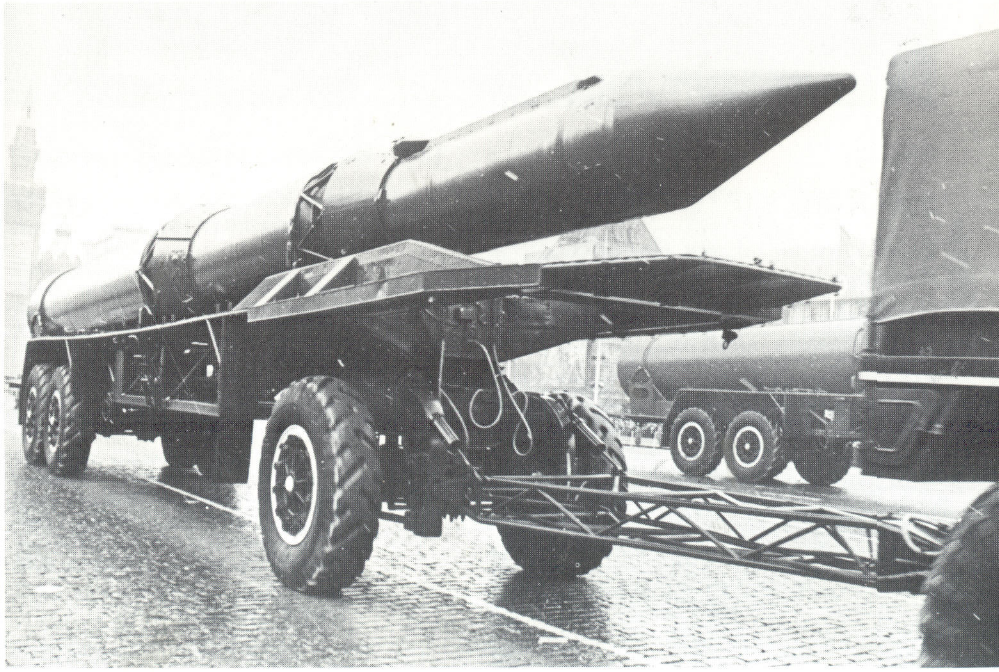
Intercontinental ballistic missile. In service.

Powered by: Three solid-propellant stages, each with four nozzles
Airframe: Three-stage missile, with truss structure between stages. Each stage is cylindrical, of progressively-reduced diameter, with a flared skirt over its nozzles. Pointed conical nose-cone
Guidance and Control: Probably inertial. Control by movable nozzles.
Warhead: Single warhead of one megaton yield or possibly three MRVs
Length: 66ft 0in (20.0m)
Body diameter (excluding skirt):
1st stage 5ft 6in (1.68m)
2nd stage 4ft 7.5in (1.40m)
3rd stage 3ft 2.5in (0.98m)
Launch weight: approx 77,160lb (35,000kg)
Max range: 5,000 miles (8,000km)

Development and Service
This Russian counterpart of Minuteman was first displayed in a Moscow military parade celebrating the 20th anniversary of the end of World War II in Europe, on 9 May 1965.

Two SS-13s tracked by America in November 1970 each delivered a single inert warhead over a range of about 4,500 miles (7,250km).

About 60 SS-13s were deployed. In addition, the top two stages of 'Savage' are used without the first stage in the 'Scamp/Scapegoat' mobile missile system. The SS-13s are expected to be replaced by SS-16s.



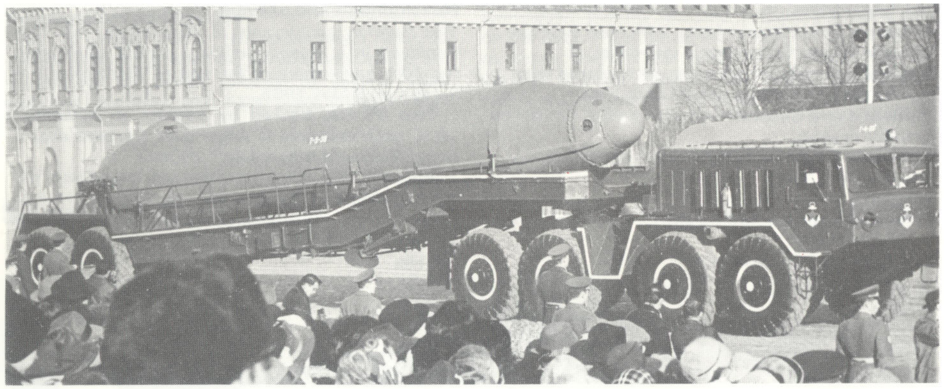
Sawfly (SS-N-6)

USSR

Underwater-to-surface or surface-to-surface missile. In service.

Powered by: Liquid-propellant motors, with four first-stage nozzles
Airframe: Probably two-stage missile. Cylindrical body of constant diameter and blunt, tapered nose-cone. No fins or wings
Guidance and Control: Inertially guided
Warhead: Megaton range. Mod 1 and 2 have a single warhead. Mod 3 has two or three MRVs
Length: 42ft 0in (12.8m)
Max body diameter: 5ft 9in (1.75m)
Range: Mod 1 1,500 miles (2,415km)
Mod 2/3 1,840 miles (2,960km)

Development and Service
'Sawfly' is considerably larger than the US Navy's Poseidon, but is estimated to have a shorter range. However, its numbers provide the Soviet Navy with a formidable attack capability against soft targets. The Mod 1 became operational in 1968, followed later by Mod 2 and 3, and a total of 34 'Yankee' class nuclear-powered submarines, each with 16 SS-N-6 tubes, had been launched by mid-1978. The original Mod 1 version has been replaced progressively by the longer-range Mod 2 since 1974. A Mod 3 MRV version of the SS-N-6 is also operational and may replace or have replaced Mod 2s. It has been reported that total 'Sawfly' production amounted to about 1,000 missiles. A newer and more formidable missile has been developed as a 'Sawfly' replacement.



SA-X-10

USSR

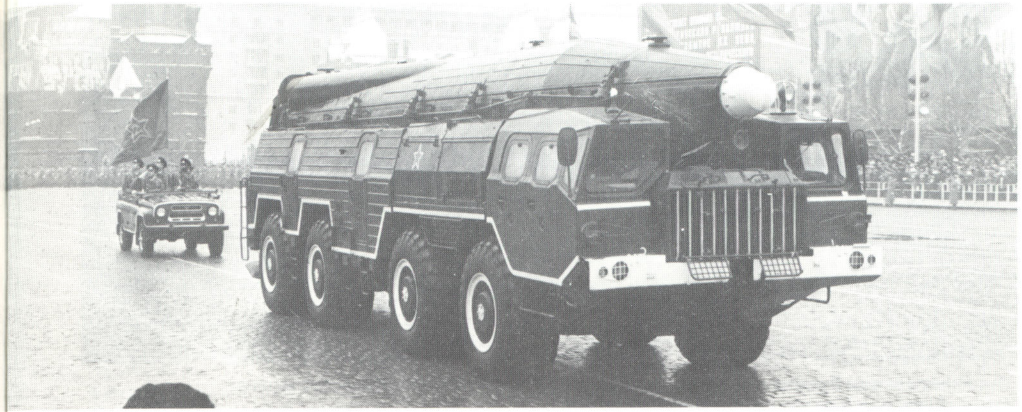
Surface-to-air missile. Under development.

Powered by: Single stage solid-propellant rocket motor
Guidance and Control: Active radar terminal homing
Length: approx 23ft 0in (7.0m)
Body diameter: approx 1ft 6in (0.46m)
Max speed: approx Mach 6
Range: approx 31 miles (50km)
Ceiling: approx 16,400ft (5,000m)

Development and Service
The SA-X-10 is under development in the Soviet Union as a strategic surface-to-air missile capable of destroying cruise missiles. It is reported to have a very high rate of acceleration and is associated with continuous wave tracking radars. Flight testing may have begun already.

Scaleboard (SS-12)

USSR



Surface-to-surface tactical missile. In service.

Powered by: Storable liquid-propellant rocket motor
Airframe: Cylindrical body, with tapered nose-cone and either tail-fins or vernier engines at base
Guidance and Control: Probably inertial guidance, set up before missile launch by means of equipment situated between two inner wheels on port side of transporter
Warhead: Probably thermonuclear in megaton range
Length: 37ft 0in (11.25m)
Body diameter: estimated at over 3ft 3in (1.00m)
Max range: 500 miles (805km)

Development and Service
First seen in November 1967, this mobile ballistic missile is about the same length as 'Scud-B' and is transported on a similar MAZ-543 eight-wheeled erector-launcher. It is, however, of larger diameter than the 'Scuds', implying a longer range, and differs in being enclosed in a ribbed casing which is elevated with it into the firing position. No photographs have yet shown the missile without this casing. During transit, the driver of the vehicle occupies the left-hand cab at the front, with the launch operator and his control console in the right-hand cab and seats for at least three other members of the launch crew to the rear of these cabs. A 'Scaleboard' replacement has already appeared in the form of the SS-22.

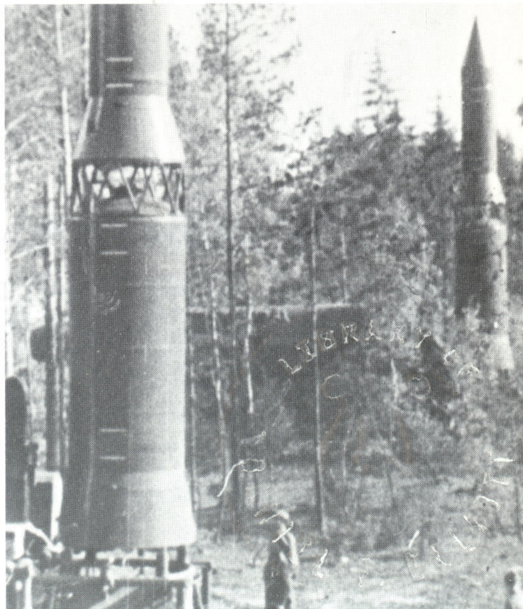
Scamp/Scapegoat (SS-14)

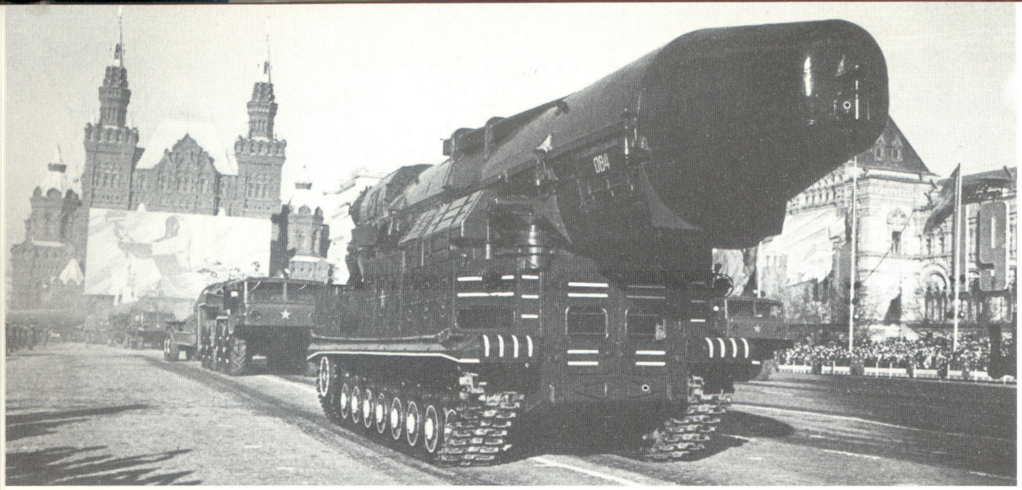
USSR

Mobile surface-to-surface ballistic missile system. In service.

Data: 'Scapegoat'
Powered by: Solid-propellant motors, with four nozzles on each stage
Airframe: Two-stage missile, with truss structure between stages. Each stage is cylindrical with a flare skirt over its nozzles. Second stage has smaller diameter than first, and is fitted with a pointed conical nose-cone
Guidance and Control: Probably inertial
Warhead: Nuclear, approx 1 MT
Length: 35ft 0in (10.6m)
Body diameter (excluding skirt):
First stage 4ft 7.5in (1.40m)
Second stage 3ft 2.5in (0.98m)
Max range: 2,500 miles (4,000km)

Right: 'Scapegoat' missiles in firing position.





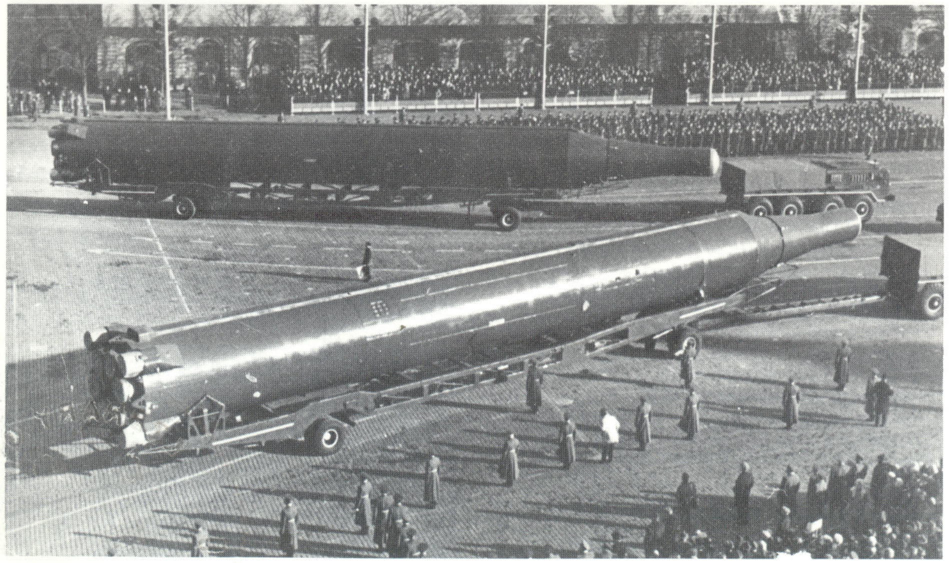
Above: 'Scamp/Scapegoat' system.

Development and Service

First included in a Moscow parade to mark the 20th anniversary of the end of World War II, on 9 May 1965, this tracked weapon system was nicknamed 'Iron Maiden' by Western observers. This reflected the fact that the missile is enclosed in a container which is made in two halves, split horizontally and hinged. For firing, a massive hydraulic jack on each side of the vehicle, at the rear, raises the container to a vertical position. The container is then opened and moved away from the missile before the latter is launched.

For several years the configuration of the missile carried by the tracked erector/launcher was not known; the complete weapon system was therefore given the NATO code-name 'Scamp'. The separate code-name 'Scapegoat' was given to a two-stage IRBM first displayed on a trailer in 1967, which appeared to consist of the top two stages of the ICBM known as 'Savage'. Not until later did official Soviet films of missile exercises reveal 'Scapegoat' to be the missile carried inside the 'Scamp' container. The original type of tracked vehicle has been superseded by an improved model, similar to that used in the 'Scrooge' weapon system. Like the latter, 'Scamp/Scapegoat' has been reported in operational service in Outer Mongolia, adjacent to the Chinese frontier.

Scarp (SS-9/FOBS) USSR



D.F. ELLIOTT

Intercontinental ballistic missile, and fractional orbital bombardment system. In service.

Powered by: Liquid-propellant rocket motors. Ring of six first-stage nozzles is surrounded by four equi-spaced vernier nozzles
Airframe: Three-stage missile. Cylindrical body of constant diameter, which tapers near the top to blend with cylindrical re-entry vehicle of much smaller diameter. Wedge-shaped fairings over vernier nozzles at tail. No fins or wings
Guidance and Control: Inertial
Warhead: Four alternative warheads have been tested: a single 20- or 25-megaton charge; an unguided MRV comprising three separate re-entry vehicles each with a yield of 4-5 megatons; and the FOBS 'space-bomb'. A MIRV warhead was under development
Length: 121ft 5in (37m)
Body diameter: 10ft 0in (3.05m)
Launch weight: approx 440,925lb (200,000kg)
Max range: 7,500 miles (12,070km)

Development and Service

When first revealed, 'Scarp' was the most formidable weapon in the world, with a thermonuclear warhead of 20/25-megaton yield. This throw weight may have been doubled in the new Soviet SS-18. It was first deployed in 1965 and first exhibited in the Moscow parade of 7 November 1967, marking the 50th anniversary of the Communist Revolution. Four days earlier, the American Secretary of Defense had announced the existence of a Soviet 'space bomb' which was first tested, in the guise of the Cosmos 139 satellite, on 25 January 1967. During many subsequent tests, inert 'space bomb' payloads were sighted optically from the Royal Aircraft Establishment at Farnborough, and are estimated to be about 6ft 6in (2.0m) long and 4ft (1.2m) in diameter. The 'space bomb' version of 'Scarp' is known in America as a fractional orbital bombardment system (FOBS). This reflects the fact that the rocket puts its thermonuclear payload into an orbit about 100 miles (160km) above the Earth. At a pre-determined point, before completion of the first orbit, the payload is intended to be slowed by retro-rocket so that it will drop precisely on to its target. It is not thought that FOBSs are deployed at any of the regular SS-9 sites.

As an alternative to its single very large warhead, the standard SS-9 ICBM can carry a simple, unguided multiple re-entry vehicle (MRV) made up of three separate smaller charges. During one test in 1970. observed by US reconnaissance satellites and naval vessels, an MRV travelled about 5,500 miles (8,800km) and re-entered the atmosphere with its three inert warheads dispersing to impact 80 miles (130km) apart — about the same distance that separates a cluster of three typical US Minuteman ICBM silo launchers. There is also reason to believe that 'Scarp' can be used as a depressed trajectory missile and has been used as launcher for the Cosmos satellites which have intercepted and destroyed other test satellites in orbit. 288 'Scarp' ICBMs were emplaced in the Soviet Union. All are 'hot launched'. Replacement with SS-18s began a few years ago.

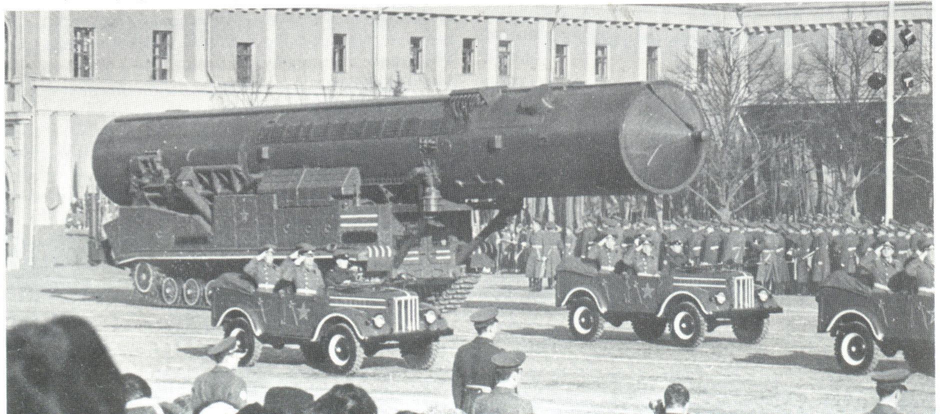
Scrooge (SS-XZ) USSR

Mobile strategic weapon system. In service.

Powered by: Solid-propellant rocket motors
Warhead: Thermonuclear or nuclear
Length of launch-tube: 62ft 0in (18.90m)
Diameter of launch-tube: 6ft 6in (2.00m)
Max range: 3,500 miles (5,600km)

Development and Service

Despite an obvious similarity in concept to the 'Scamp/Scapegoat' weapon system, 'Scrooge' remains one of the Soviet Union's lesser-known strategic missiles. The container, housing the missile, is raised vertically for firing, but does not hinge open and is used as a launch-tube. Its length suggests that the missile is much longer than 'Scapegoat' and would therefore have a greater range. It has been suggested that the missile is a modified SS-13 with a less powerful first stage. However, the SS-16 is another possibility. Otherwise little is known about 'Scrooge' except that it has been observed in first-line service on the frontier between Outer Mongolia and China.



Scud-B (SS-1c) and Scud-C

USSR

Surface-to-surface missile. In service.

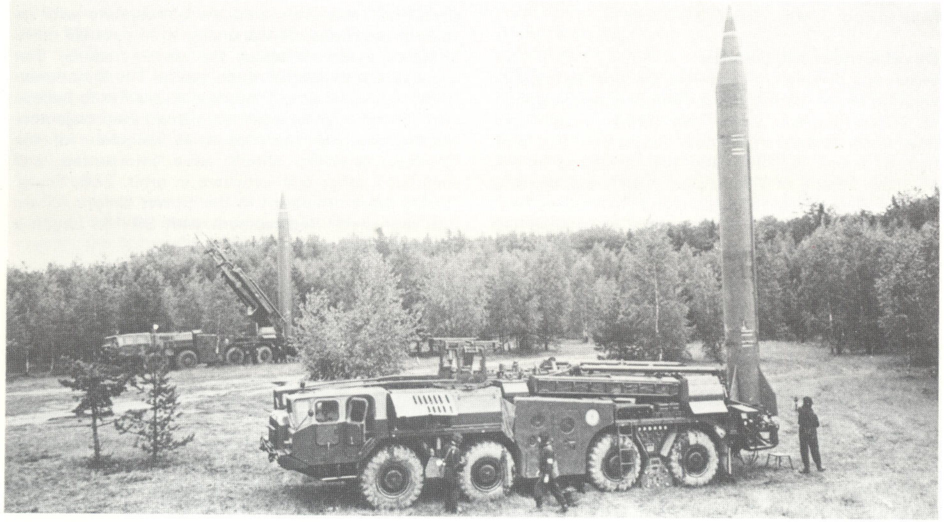
Powered by: Storable liquid-propellant rocket motor
Airframe: Cylindrical single-stage metal structure, with movable cruciform tail-fins and pointed nose-cone
Guidance and Control: Simplified inertial guidance system; possibly limited radio command during flight. Control by vanes in rocket motor efflux
Warhead: Optional nuclear or high-explosive
Length: 37ft 0in (11.25m)
Body diameter: 2ft 9.5in (0.85m)
Launch weight: approx 13,890lb (6,300kg)
Range: 174 miles (280km)

Development and Service

Enlarged to provide increased propellant tankage, and hence longer range, this improved 'Scud' first appeared on the same tracked vehicle as 'Scud-A'. It was then seen, in November 1965, on the MAZ-543 eight-wheeled transporter/erector/launch vehicle, which has since become standard. It is supported on a similar cradle to that formerly used for 'Scud-A', which is thought to be no longer in first-line service, with integral ladders at the sides. The launch vehicle is reloadable. Other vehicles that form a 'Scud' battery include a meteorological unit, a tanker vehicle, command/control vehicles, reload and crane loading vehicles.

'Scud-Bs' are operated by the forces of Bulgaria, Czechoslovakia, Egypt, East Germany, Hungary, Iraq, Libya, Poland, Romania, Syria and the USSR. Reports have been made of a larger 'Scud-C' missile, with a range of 280 miles (450km).

Below: 'Scud-B'.



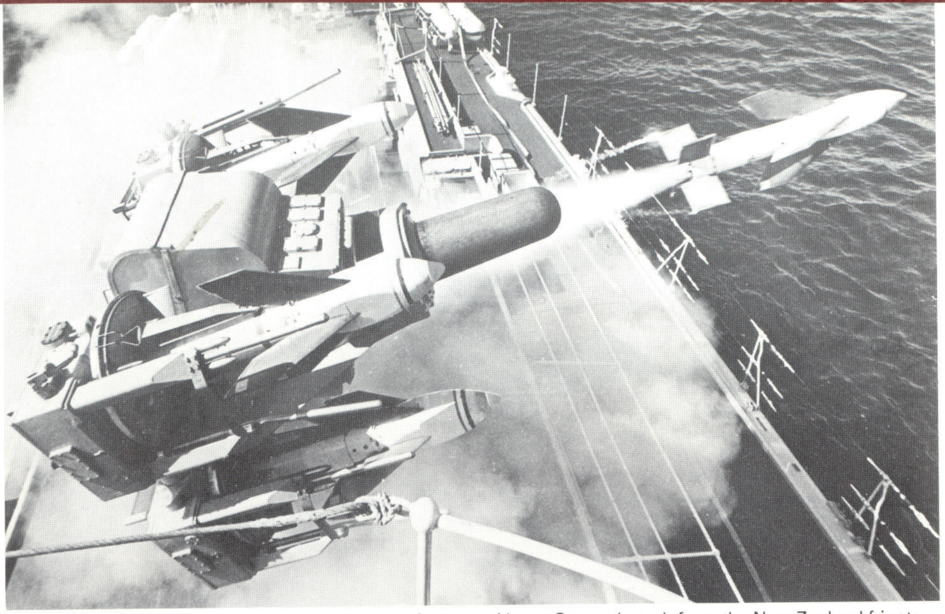
Seacat (Swedish Navy designation RB07)

UK

Surface-to-air and surface-to-surface ship-based close-range missile. In production and service.

Prime contractor: Short Brothers Ltd
Powered by: IMI two-stage solid-propellant rocket motor
Airframe: Basically-cylindrical body, changing to wider and more square cross-section on forward portion and with a pointed ogival nose. Pivoted cruciform sweptback wings, indexed at 45 degrees to fixed cruciform tail-fins, two of which carry tip-mounted tracking flares
Guidance and Control: Radio command , with visual or radar tracking. Control by pivoted wings
Warhead: High-explosive, with contact and proximity fuses
Length: 4ft 10.3in (1.48m)
Max body diameter: 7.5in (0.19m)
Wing span: 2ft 1.6in (0.64m)
Weight: approx 140lb (63kg)
Max range: estimated at over 2.95 miles (4.75km)

Development and Service



Above: Seacat launch from the New Zealand frigate HMNZS *Taranaki.*

Seacat has proved one of the most widely-exported guided weapons in the world. Its development started under a contract awarded in April 1958. Within four years sea trials were underway from HMS *Decoy*. Today, in addition to the Royal Navy, a total of 15 other nations deploy this small and highly-manoeuvrable close-range weapon system on their naval craft. Production continues and Seacat is expected to remain in service well into the 1990s.

Simplest of many different fire control systems in service is the Mk 20, in which the standard four-round launcher is controlled by two men in a director unit. One rotates the director so that the second (the aimer) can pick up and track the target through binoculars. The launcher is 'slaved' to the director in azimuth and elevation, with the result that missiles enter the aimer's field of vision soon after launch. The aimer guides each missile to the target by means of a small joystick, using flares on the missile as a tracking reference. The Mks 21 and 22 radar systems provide auto-follow of the target, permitting both visual and 'dark' firings, and successful trials have been completed for a system which replaces optical sighting with closed-circuit TV. Sweden and Chile use a Dutch M4/3 radar system; Argentina uses an Italian system. Brazil and Iran utilise a new lightweight Seacat system, with a three-round launcher, which can be accommodated in vessels as small as fast patrol boats and minesweepers. The lightweight launcher, with all its ancillaries, weighs only 4,425lb (2,007kg) as compared with the 10,360lb (4,700kg) of the standard four-round Mark 20 launcher. Seacat missiles can now be fitted either as new or as a retro-active modification with the height control device for surface-to-surface application.

Sea Dart (CF.299)

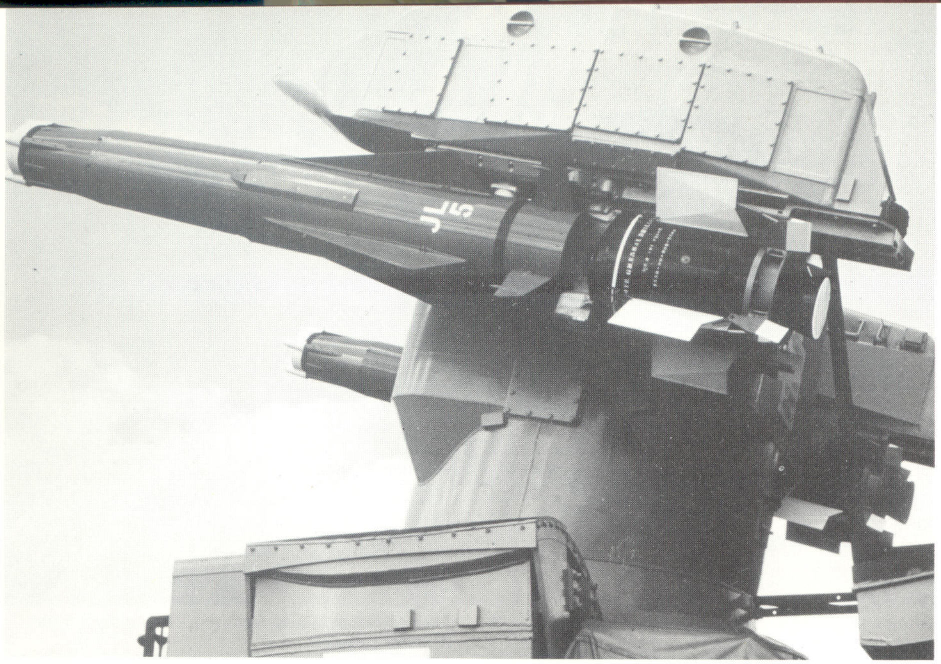
UK

Ship-based surface-to-air and surface-to-surface missile. In production and service.

Prime contractor: British Aerospace Dynamics Group
Powered by: Rolls-Royce Odin ramjet and tandem jettisonable IMI solid-propellant rocket booster. Between-stage vents enable the Odin to be started prior to staging.
Airframe: Missile has cylindrical body with four interferometer aerials around nose intake for ramjet. Rear-mounted long-chord cruciform wings indexed in line with cruciform tail control surfaces. Larger-diameter cylindrical booster has cruciform fins that fold forward while the missile is on its launcher
Guidance and Control: Marconi semi-active radar homing guidance. Control by tail surfaces.
Warhead: High-explosive, with EMI proximity fuse
Length: 14ft 3.5in (4.36m)
Body diameter: 1ft 4.5in (0.42m)
Span: 2ft 11.75in (0.91m)
Launch weight: 1,210lb (550kg)
Range: at least 19 miles (30km)

Development and Service

Development of Sea Dart (originally CF.299) was started in 1962, to provide a weapon that would represent a major improvement on Seaslug and yet be compact enough to install on ships smaller than those fitted with the earlier missile. Choice of a ramjet sustainer has made Sea Dart a genuine area-defence weapon, capable of intercepting aircraft and air-launched or surface-launched missiles at both very high and extremely low



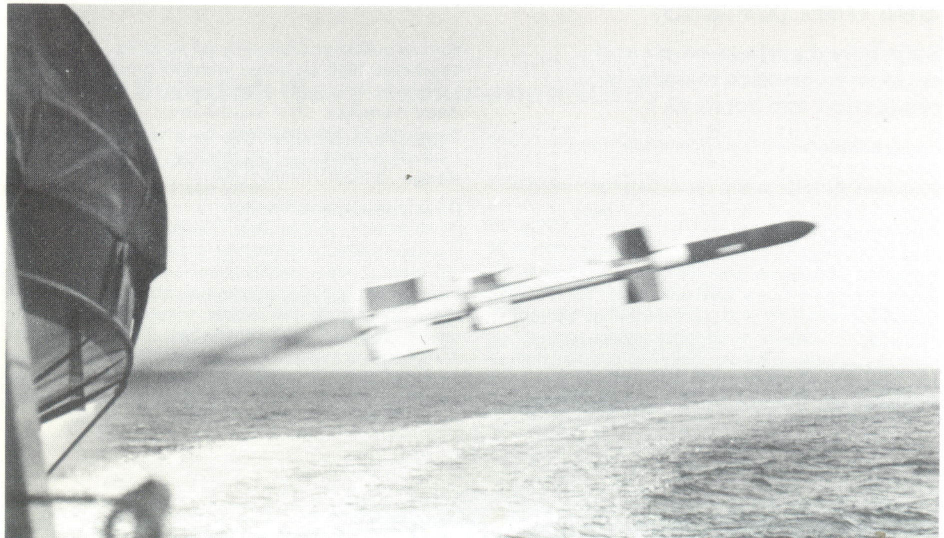
Above: Sea Dart missile launcher on board HMS *Bristol*.

altitudes, with added effectiveness against surface targets. Firing trials began in 1965, confirming that the weapon system offered a rapid launch-rate and the capability of dealing with many targets simultaneously. Production was initiated in 1967 and the first ship to be fitted with the Sea Dart system was the guided missile destroyer HMS *Bristol*, which has a twin-launcher. A similar launcher has been fitted on each of the Type 42 destroyers of the Sheffield class and on two further ships of this class for the Argentine Navy, in addition to ARA *Hercules* of the Argentine Navy. It will also provide area defence for the Royal Navy's new Invincible class of anti-submarine command cruisers. The Sea Dart system utilises a surveillance radar, two Marconi Type 909 tracking/illuminating radars, a Vickers twin-launcher and handling system, a Ferranti computer for target selection and data handling, a Sperry Gyroscope missile control system and Plessey Radar operations room display equipment.

A Mk 2 version of Sea Dart is currently under development. It will incorporate a new rocket booster with thrust-vector control and miniaturised electronics.

Sea Killer Mk 2

Italy



Surface-to-surface ship-launched missile. In service.

Prime contractor: Sistel-Sistemi Elettronici SpA
Powered by: SEP 299 solid-propellant booster, rated at 9,702lb (4,400kg) st for 1.6 seconds, and SEP 300 solid-propellant sustainer, rated at 220lb (100kg) st for 73 seconds
Airframe: Cylindrical light alloy body, with ogival nose-cone. Pivoted cruciform wings of rectangular shape mounted mid-way back on second stage and indexed in line with cruciform tail-fins. Tandem booster with large rectangular cruciform fins indexed in line with second-stage surfaces
Guidance and Control: Guidance by beam-riding/radio command, in conjunction with radar altimeter. Control by movable wings
Warhead: High-explosive, semi armour-piercing, with impact/proximity fuse. Weight 154lb (70kg)
Length: 15ft 5in (4.70m)
Body diameter: 8.1in (0.206m)
Wing span: 3ft 3.5in (0.999m)
Launch weight: 660lb (300kg)
Cruising speed: Mach 0.74
Max range: over 15.5 miles (25km)
Cruising height: Programmed down to 6ft 6in (2.00m)

Development and Service
This Mk2 version of Sea Killer (known for a time as Vulcano) is a two-stage missile, with tandem booster, enabling it to carry a heavier warhead and giving a greatly increased range, at a high subsonic cruising speed. Flight trials started in mid-1969, followed by the first weapon system qualification trials in mid-1971. Limited weight, size and cost suit Sea Killer Mk2 for installation on craft ranging from fast patrol boats to destroyers and frigates, and it is operational on frigates of the Iranian Navy. It can be integrated in ships armed with conventional weapons, fire control radars and systems. If this equipment is not already installed, integration requires the addition of a radar transmitting system, computer, missile control console and closed-circuit television. Sea Killer Mk2 is compatible with the same Contraves shipboard systems as the now obsolete Mk 1 version. It is used in the Marte air-to-surface and Mariner surface-to-surface anti-ship weapon systems.

Sea Skua (CL834)

UK

Air-launched anti-ship missile. Under development.

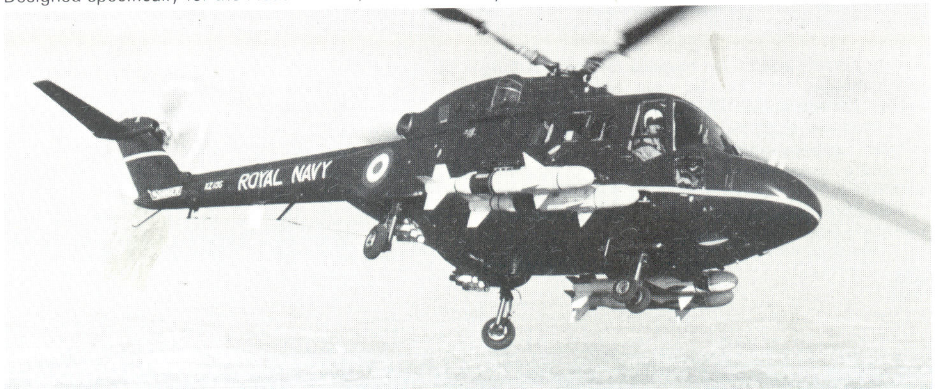
Prime contractor: British Aerospace Dynamics Group
Powered by: Two-stage solid-propellant boost and sustainer rocket motor
Airframe: Two-diameter cylindrical body, joined one-third-way along length by tapered section. Cruciform foreplane control surfaces, indexed at 45 degrees to cruciform tail-fins
Guidance and Control: Semi-active radar homing head. Radio-altimeter to maintain low cruising height. Control via movable control surfaces
Warhead: 44lb (20kg) weight
Length: 9ft 3.5in (2.83m)
Body diameter: 10.5in (0.27m)
Foreplane span: 1ft 11.5in (0.60m)
Launch weight: 325lb (147kg)
Max speed: High subsonic
Max range: approx 8.7 miles (14km)

Development and Service
Designed specifically for the Fleet Air Arm, Sea Skua is a lightweight all-weather 'sea skimming' missile which will be carried by frigate-borne Lynx helicopters to provide long-range defence for such ships against missile-armed fast patrol boats, hydrofoils and hovercraft. It will also be capable of inflicting heavy damage on frigates and larger vessels. Four missiles will be carried by each helicopter.

The complete system based on the Sea Skua missile will allow targets to be located, identified and engaged over the horizon from the carrier frigate. The Lynx helicopter will have a Ferranti Seaspray radar for target acquisition and illumination. No on board maintenance or testing is required.

BAC began the first phase of missile development in 1972. Project definition was complete by the autumn of 1975, when government approval for full development was announced. Sea Skua will enter service in the early 1980s. It can also be fitted to other helicopters and fixed-wing maritime patrol aircraft.

Below: Sea Skua missiles carried by a Royal Navy Lynx HAS Mk 2.



Seaslug

UK

Surface-to-air and surface-to-surface ship-launched missile. In service.

Prime contractor: British Aerospace Dynamics Group
Powered by: ICI solid-propellant rocket motor. Four jettisonable solid-propellant wrap-round boosters
Airframe: Cylindrical light alloy body with pointed nose-cone. Cruciform wings mid-way back on body, indexed in line with cruciform pivoted tail control surfaces. Flat-nose boosters extend forward from wings to nose of missile
Guidance and Control: General Electric beam-riding guidance system, utilising Type 901M shipboard radar. Control via movable tail surfaces
Warhead: High-explosive, with proximity fuse
Length: Mk 1 19ft 8in (6.00m)
Mk 2 20ft 0in (6.10m)
Body diameter: 1ft 4.1in (0.41m)
Wing span: 4ft 8.6in (1.44m)
Range: Mk 1 28 miles (45km)
Mk 2 36 miles (58km)
Effective height: over 9.3 miles (15km)

Above: Seaslug launch at sea.

Development and Service

Although virtually obsolete as a long-range anti-aircraft missile, Seaslug is still installed on twin launchers in each of the seven destroyers of the Royal Navy's County class. Three of these ships have the Mk 1 version of Seaslug, which achieved a 90% success rate in launchings against fast target drones at both high and low altitudes during its development testing in the latter 1950s. The Seaslug Mk 2, in the last four ships, offers longer range, improved performance against low-level targets, and improved surface-to-surface capability.

In operation the launcher is automatically loaded. When a target is located, the system automatically tracks it and points the launcher. When the target is within range the missile is launched. For long-range surveillance, a Type 965 radar is used. For height locating, a Type 227 radar is used, and for missile tracking and illuminating a Type 901 radar.

Sea Sparrow (RIM-7H)

USA

Ship-launched surface-to-air and surface-to-surface close-range missile. In production and service.

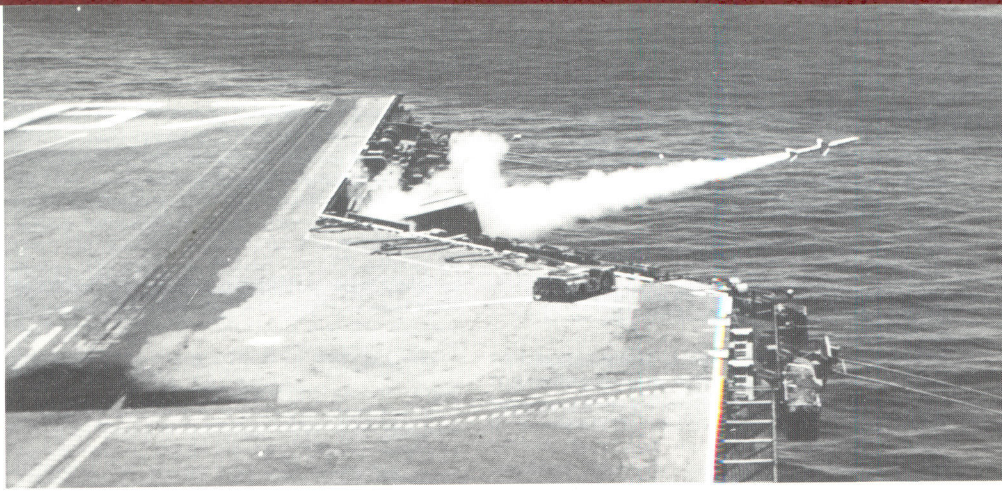
Prime contractor: Raytheon Company
Airframe: Cylindrical body with pointed ogival nose. Folding cruciform wings to reduce size of its launcher, and cruciform tail surfaces

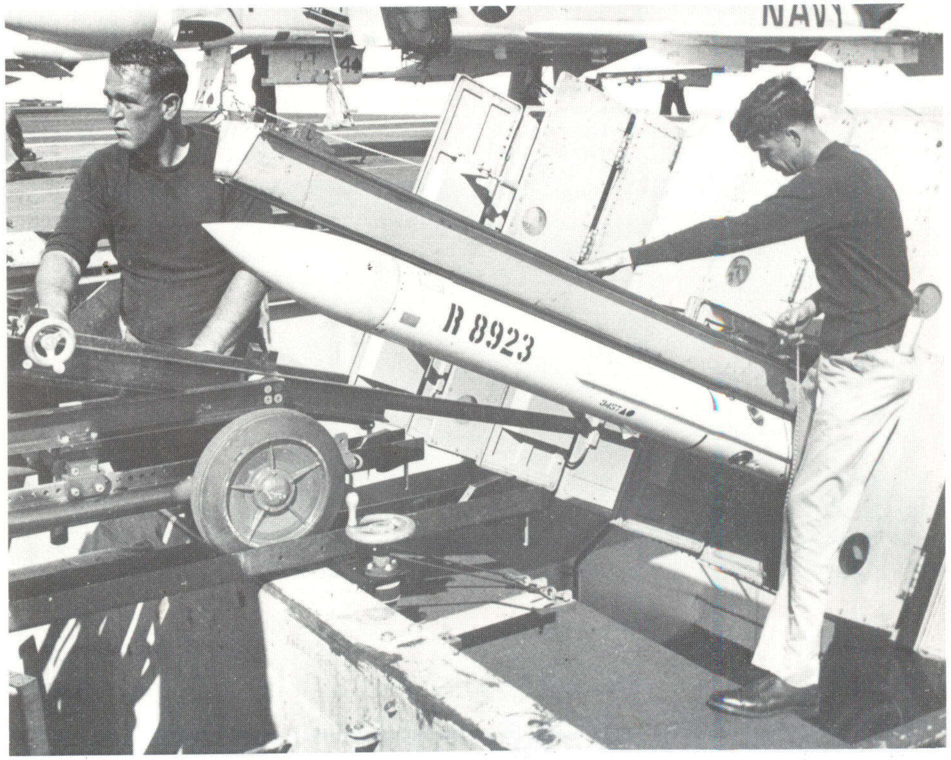
Development and Service

Work on Sea Sparrow began in 1964, under the US Navy designation Basic Point Defence Missile System (BPDMS), to provide protection against enemy aircraft and cruise missiles for ships lacking other missile systems. To save time, the Basic version utilised standard AIM-7E Sparrow III missiles in a modified eight-round Asroc launcher (AIM-7F version subsequently became available). The complete system is mounted on a modified automatic gun carriage and weighs 39,000lb (17,690kg). The Sparrow's CW semi-active radar homing system is unchanged. Shipboard equipment includes a Mk 51 director/illuminator to acquire and illuminate the target, the manually-operated Mk 115 fire control system being supplied with the necessary target data from the ship's combat information centre. First ships to be fitted with the BPDMS were US Navy attack carriers. Altogether approximately 74 US ships carry the system; 16 missiles were ordered in 1975 for installation on Japanese frigates and several Spanish (and possibly Venezuelan vessels) will carry Sea Sparrow.

An Improved PDMS, known as NATO Sea Sparrow Missile System (NSSMS), was developed by Raytheon in partnership with companies in Belgium, Denmark, Germany, Italy, the Netherlands and Norway under an agreement signed by all but two of these countries in 1968. This retains the Sparrow missile in conjunction with a new lightweight eight-round launcher, a fire control system based on digital computers, a target acquisition system and a powered director/illuminator. In March 1972 the first shipborne launch took place. US Navy technical and operational evaluation was completed during 1974 on board USS *Downes*, and was followed by evaluation on board the Royal Norwegian Navy destroyer KNM *Bergen* in far-northern environment conditions. Orders for the system were then made for the navies of all participating countries. By adding a Hughes target acquisition system (TAS), NSSMS can be improved to detect automatically cruise missiles flying at low altitude at a range of more than 23 miles (37km) and aircraft at 100 miles (161km).

A Canadian Sea Sparrow missile system, known as the Close Range Missile System, has also been developed, and is installed in four destroyers of the Canadian Armed Forces. All ship-launched Sparrow systems can be used in a surface-to-surface role.





Top: Sea Sparrow launched from USS *John F. Kennedy.*

Above: Sea Sparrow launcher on board USS *Enterprise.*

Seawolf

UK

Close-range surface-to-air and surface-to-surface missile. In production and service.

Prime contractor: British Aerospace Dynamics Group
Airframe: Cylindrical body with pointed nose. Cruciform delta wings and cruciform tail control surfaces indexed in line
Guidance and Control: Radar guidance normal. TV tracking for low angle or surface-to-surface attack. Control via movable tail surfaces
Warhead: High-explosive, with proximity and contact fusing
Length: 6ft 7in (2.0m)
Wing span: 2ft 3.5in (0.70m)
Launch weight: 176.4lb (80kg)
Max speed: Supersonic

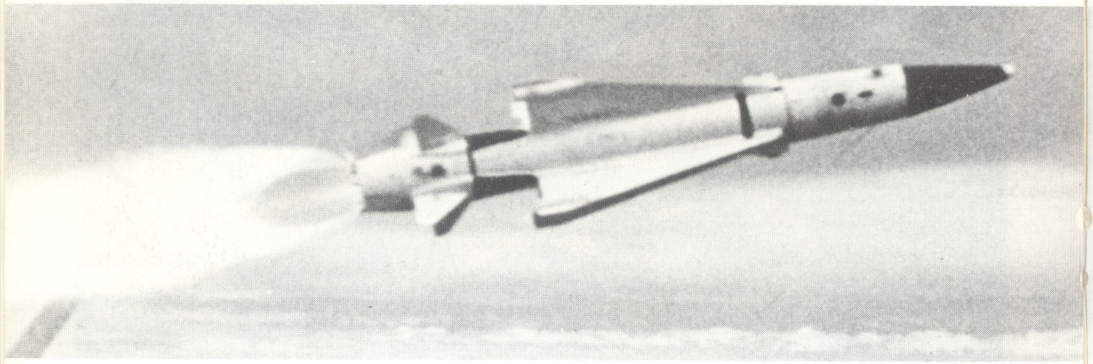
Development and Service
BAC received a contract in June 1967 to develop an advanced surface-to-air weapon system which was then designated PX430 and is now known as Seawolf. Intended as a follow-on to Seacat (qv) it is an all-weather system, giving greatly improved defence capability against supersonic anti-shipping missiles and aircraft, and is suitable for surface-to-surface use against ships and hovercraft.

The Seawolf missile with Marconi Radar systems surveillance radar and blindfire differential tracker radar together with Vickers six-barrel launcher make up Guided Weapon System 25 (GWS 25), and is currently fitted in HMS *Broadsword*, the first Royal Navy Type 22 frigate. This class of frigate carries two trackers and two launchers, and three more Type 22s are under construction.

During firing trials, Seawolf missiles intercepted Mach 2 missile targets and 4.5in shells.

In operation, any error in the missile's course is signalled from the differential tracking radar or television to the guidance shaping unit. Coded correction signals are then passed by microwave radio command link to the missile. Seawolf is suitable for installation in frigates and larger ships. For smaller ships than the Type 22s, and to improve performance against the surface skimming missile, BAeDG have collaborated with SIGNAAL to offer a system of 6.5 tons comprising a lightweight (STIR) tracker and a lightweight power loader from below launcher. This system is known as Seawolf VM40.

Below: Seawolf missile during firing trials.



Sego (SS-11)

USSR

Intercontinental ballistic missile. In service.

Powered by: Storable liquid-propellant rocket engines
Warhead: Thermonuclear, of 1-2 megaton yield, with radar decoys. Alternatively, a multiple re-entry vehicle (MRV), with three separate charges and decoys
Guidance and Control: Ground-based computers issue steering instructions by radio during powered flight phase
Max range: 6,525 miles (10,500km)

Development and Service
Little is known about the SS-11, although 1,018 of the Soviet ICBMs emplaced were of this type. It is said to have been operational in camouflaged silo launchers since 1966 and is being replaced by the SS-17 and SS-19. US monitoring services reported that two SS-11s, with warheads equivalent to a one-megaton charge, were launched 5,715 miles (9,200km) from Tyuratam test site in Kazakhstan into the Pacific on 27 and 28 July 1970. Two more SS-11s were identified at the end of 6,525 mile (10,500km) flights with MRV warheads on 21 August 1970. A further nine flights were made by SS.11 missiles during February 1973 from near Lake Baikal to a point on the Kamchatka Peninsula.

Altogether three versions of the SS-11 have been reported, the basic version with a single warhead, a version with a more accurate re-entry vehicle, and a version with MRV warhead. The first of these makes up the majority of operational SS-11s, while the second is not thought to be operational and at least 60 of the third type are operational, each probably carrying three 300-kiloton yield MRVs.

Serb (SS-N-5)

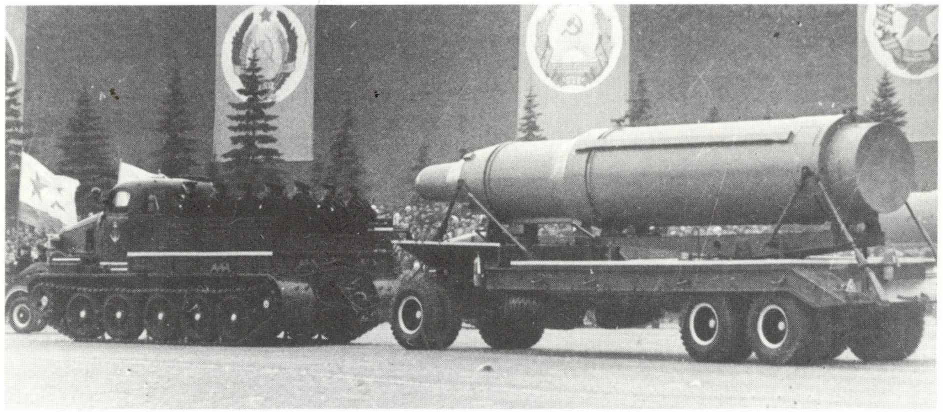
USSR

Underwater-to-surface or surface-to-surface missile. In service.

Powered by: Solid-propellant motors. Eighteen small gas-jets at base for ejection from launch tube
Airframe: Two-stage missile. Both stages and round-nosed re-entry vehicle are cylindrical, of progressively-reduced diameter, with tapered fairing between each. No fins or wings
Guidance and Control: Inertial guidance
Warhead: Single re-entry vehicle, warhead in megaton range
Length: 35ft 1in (10.7m)
Max body diameter: 4ft 8in (1.42m)
Max range: 750 miles (1,200km)

Development and Service
This Polaris-type weapon was first shown in a Moscow parade in November 1964, suggesting that it represents an intermediate stage between the SS-N-4 'Sark' and the SS-N-6 'Sawfly'. It was described from the start as being suitable for underwater launch from Soviet submarines. After three years, in a 1967 parade, the usual cover-plate over the base was removed to reveal the nozzles for the electrically-detonated cold-gas system by which 'Serb' is ejected from its launch-tube for above-the-surface ignition of the first-stage motor.

This missile is carried by about seven Soviet 'Hotel II' class submarines, each with three tubes. It is, however, considered to be obsolescent.



Shaddock (SS-N-3) and Sepal (SSC-1B)

USSR

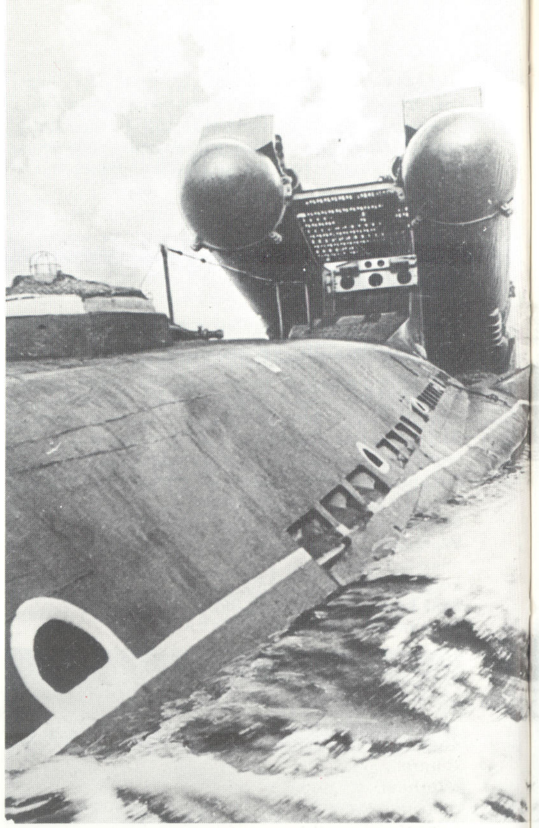
Surface-to-surface cruise missile. In service.

Powered by: Ramjet or turbojet cruise motor, plus two large solid-propellant JATO boosters
Airframe: Basically bullet-shape body, probably with two short-span hinged wings at mid-point and with pointed ogival nose-cone. Two jettisonable boosters under tail, to each side of large ventral fin
Guidance and Control: Command guidance. Possible active radar homing system
Warhead: Nuclear or high-explosive
Length: 35ft 9in-42ft 8in (10.9-13m)
Max speed: Mach 0.95-1.4
Useful range: estimated 115 miles (185km)
Max range: estimated up to 520 miles (840km)

Development and Service
Cruise missiles of the subsonic and transonic 'flying bomb' type continue to serve in important roles in the Soviet armed forces despite the possibility that the SS-N-12 replacement is ready for operational service. The formidable 'Shaddock' is carried as a standard weapon by many surface ships and submarines. Four large destroyers known to NATO as the 'Kresta 1' class each carry four 'Shaddocks' in

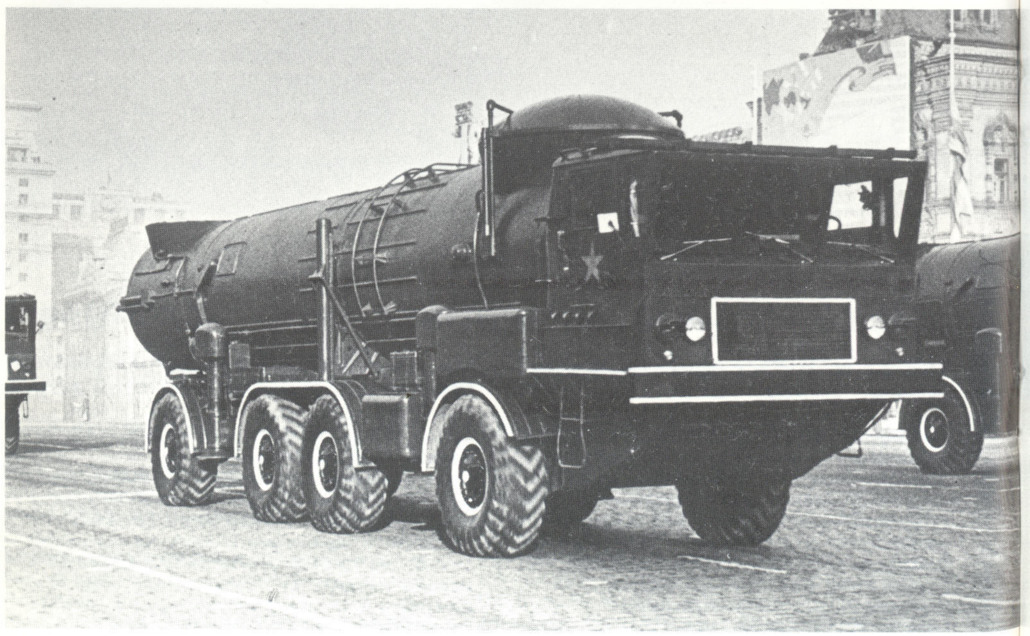
two twin launch-tubes, without reload capability. This armament is more than doubled on the four destroyers of the Kynda class, each of which has four launch-tubes in a side-by-side cluster on the foredeck and four more on the after deck, almost certainly with eight more missiles in store for a second strike. Each ship carries 'Scoop Pair' radar. About 50 submarines are thought to be armed with 'Shaddock'. The nuclear-powered 'Echo II' class carries eight missiles; the 'Juliet' class carry four each; and the converted 'Whisky' class carry four in what are known as longbin containers. 'Shaddock' is also land-based in the SSC-1B 'Sepal' coastal defence weapon system, which is based on an eight-wheeled vehicle. Each 'Sepal' battalion is reported to have up to 18 missiles.

'Shaddock' has never been revealed in public and the above description is based on what can be seen through the open ends of missile containers mounted on trucks which have taken part in parades through Moscow. It is generally thought that there might be some differences between the naval and land-based Shaddocks, and that several different missiles of this type may be in naval use. The drawing is based on one which appeared in an official East German magazine, but has been modified to conform with known details of the nose and tail configuration. No details of the air intake for the cruise engine are known, but this could be annular like that of 'Ganef' (qv).



Right: 'Shaddock' missile launchers on 'Whisky' class submarine.

Below: 'Sepal' missile carrier.



Shahine

France

Surface-to-air missile. In production.

Prime contractor: SA Matra
Powered by: Single-stage solid-propellant rocket motor
Airframe: Similar to Crotale
Warhead: As for Crotale
Length: approx 9ft 10in (3.00m)
Body diameter: 5.9in (0.15m)
Wing span: 1ft 9.25in (0.54m)
Range: 6.5 miles (10.5km)

Development and Service
The Shahine missile system is based on Crotale and has been ordered by Saudi Arabia. Compared with the Crotale missile, the Shahine missile is a little longer because of its uprated rocket motor, which increases range, and the launcher for six missiles is mounted on an AMX30 tank chassis. The surveillance radar is also mounted on its own tracked vehicle. Up to four launch vehicles can accompany each radar vehicle, and can be associated with AMX30SA 30mm cannon anti-aircraft tanks and rocket defence weapons.

Trial firings of Shahine began in 1977 and delivery to Saudi Arabia is expected in 1980.

Shafrir

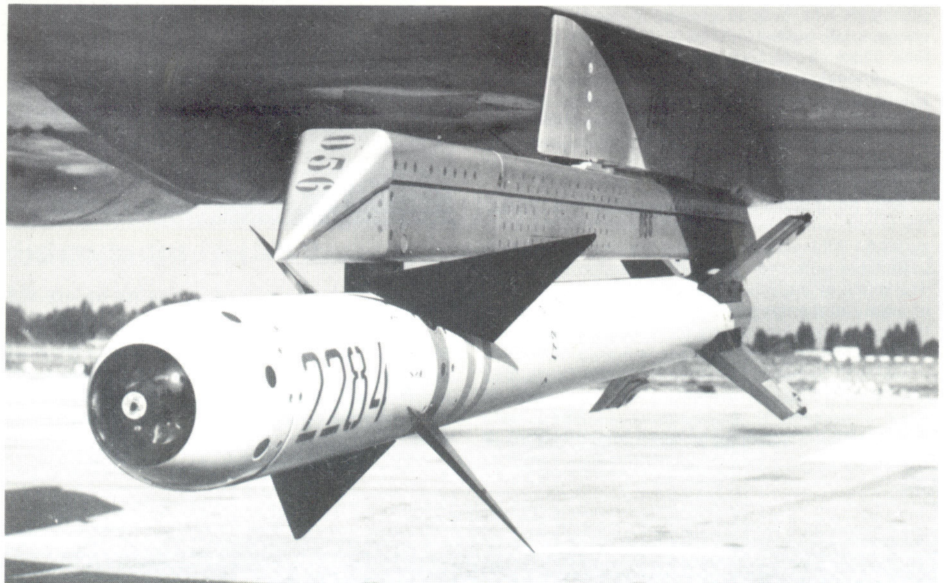
Israel

Short-range air-to-air missile. In production and service.

Prime contractor: Rafael Armament Development Authority
Powered by: Solid-propellant rocket motor
Airframe: Cylindrical body with rounded nose and cruciform canard control surfaces indexed in line with cruciform tail-mounted wings
Guidance and Control: Infra-red seeker head. Control via canard surfaces
Warhead: High-explosive, weight 24.25lb (11kg), with impact or proximity fuse
Length: 8ft 1.5in (2.47m)
Body diameter: 6.3in (0.16m)
Wing span: 1ft 8.5in (0.52m)
Launch weight: 205lb (93kg)
Max range: 3.1 miles (5km)
Effective ceiling: 60,000ft (18,000m)

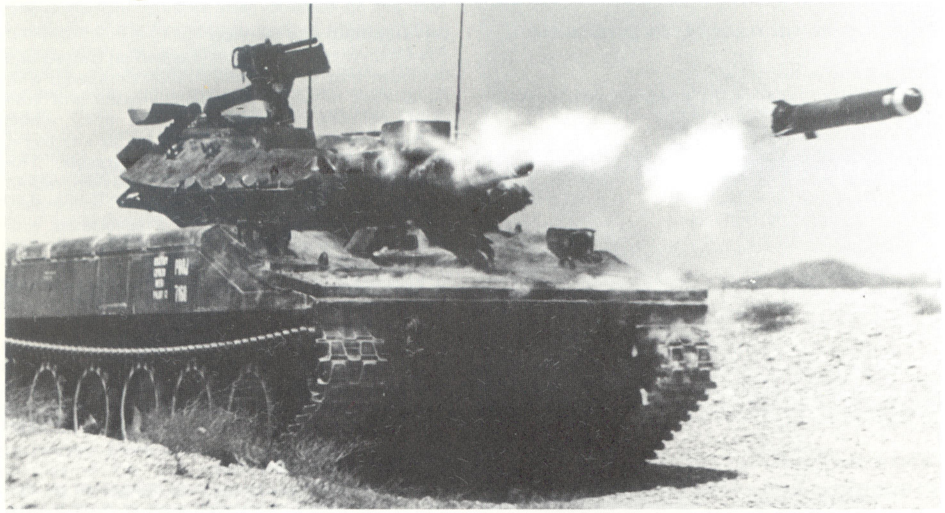
Development and Service
Development of this missile was completed by the late 1960s, when production was started. It was designed to be used against aircraft at altitudes of up to 59,000ft (18,000m). Shafrir has, since 1969, been used with considerable success in combat. During the Yom Kippur War of October 1973, a very large number of Arab aircraft were reported to have been destroyed in air combat for the loss of only a few Israeli aircraft. Of these Arab aircraft more than 100 were brought down by Shafrirs, representing approximately a 60% kill ratio to missiles fired.

In operation, if a target is detected within the firing range, an audio signal is heard and an indicator light in the cockpit is automatically switched on. These signals indicate that the missile-launch button can be pressed. Following launch, the missile's guidance system automatically tracks the target, without further assistance from the launch aircraft. Several other countries are reported to have bought Shafrir missiles, including Taiwan, Argentina, South Africa and Peru.



Shillelagh (MGM-51A)

USA



Top: Shillelagh launch from a General Sheridan AFV.

Above: Shillelagh missile.

Lightweight army close-support missile. In service.

Prime contractor: Ford Aerospace and Communications Corporation, Aeronutronic Division
Powered by: Single-stage solid-propellant rocket motor
Airframe: Round-nosed cylindrical body, with four slightly swept flip-out tail-fins
Guidance and Control: Aeronutronic command guidance system, with infra-red tracking. Control by sustainer exhaust deflection
Warhead: Octol shaped-charge
Length: 3ft 9.5in (1.14m)
Body diameter: 5.95in (0.152m)
Launch weight: 59lb (26.8kg)
Range: over 17,060ft (5,200m)

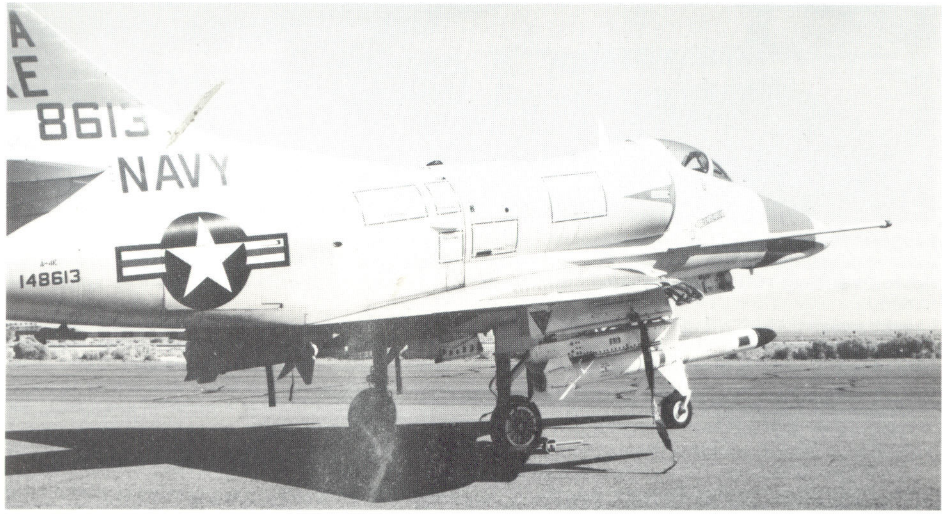
Development and Service

Shillelagh was built in greater numbers than any previous US guided missile. It is unusual in being fired from a gun/launcher that can also fire conventional ammunition. This makes it an ideal weapon for tanks and other armoured fighting vehicles, and it has been carried by General Sheridan AFVs of the US Army since 1967, including extensive overseas deployment. The system is also deployed with the M60A2 battle tank.

After firing Shillelagh, the gunner has only to keep the target centred on the cross-hairs of his telescopic sight. An infra-red missile tracking/command system associated with the sight detects and corrects any deviations of the missile's flight path from the line-of-sight to the target. Shillelagh provides greatly increased fire-power for use against all types of armoured fighting vehicles, troops and fortifications. It has been tested in a air-to-surface role from a Bell UH-1B helicopter, in conjunction with a stabilised sight developed by Aeronutronic. In 1975 tests began with an experimental laser-guided version of Shillelagh, and in the following year a Sheridan reconnaissance vehicle and an M60A2 tank were modified for further tests. This version of the missile has been referred to as Shillelagh LBR or Laser Beam Rider.

Shrike (AGM-45A)

USA



Above: Shrike under the wing of a Skyhawk.

Supersonic air-to-surface anti-radar missile. In production and service.

Prime contractor: Naval Weapons Center, China Lake, California
Powered by: Rocketdyne Mk 39 Mod 7 or Aerojet Mk 53 solid-propellant rocket motor
Airframe: Slim cylindrical body with ogival nose. Pivoted cruciform wings mid-way from nose to tail, indexed in line with cruciform tail-fins
Guidance and Control: Passive homing head by Texas Instruments/Sperry Univac. Control via pivoting wings
Warhead: High-explosive fragmentation type, with proximity fuse; weight 145lb (66kg)
Length: 10ft 0in (3.05m)
Body diameter: 8in (0.20m)
Wing span: 3ft 0in (0.91m)
Launch weight: 400lb (182kg)
Performance: Secret, but cruising speed is supersonic and range is thought to be about three miles (5km)

Development and Service

Shrike was developed initially under the acronym ARM (anti-radar missile), to home on enemy radars. The need for such a weapon was underlined by the war in Vietnam, where it became increasingly important for the Americans to knock out or jam the North's warning and missile/aircraft guidance radars during the US air offensive. Delivery to US Navy carrier-based attack squadrons began in 1964. Shrike can arm all Navy attack aircraft and most F-4 and the F-105G aircraft of the USAF; it was used widely in Vietnam from 1965. Production for the USAF was planned to continue in fiscal year 1978 (the US Navy completing their purchase in FY 1974), and many improvements have been introduced through the years to increase the weapon's effectiveness, leading to a series of 12 versions designated between AGM-45-1 and AGM-45-10, which differ primarily in the frequency coverage of the detachable seeker sections.

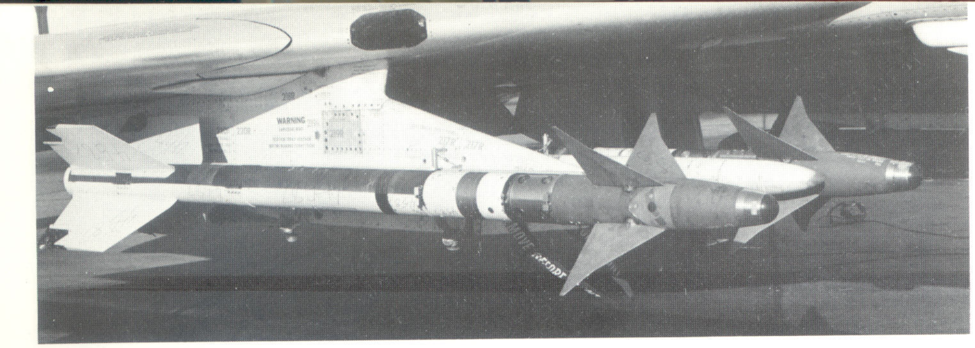
The US Navy acquired a total of 11,167 Shrikes between 1965 and 1975. Production continues for the USAF, which purchased 9,638 by FY 1974, with projected procurements to FY 1978 totalling another 3,763 missiles, many of the late models as armament for F-4G 'Wild Weasel' defence suppression squadrons.

Sidewinder (AIM-9)

USA

Air-to-air missile. In production and service.

Data: AIM-9B and *AIM-9H/L*
Prime contractor: US Naval Weapons Center, China Lake, California
Powered by: Naval Propellant Plant solid-propellant rocket motor
Airframe: Slim cylindrical aluminium body, with hemispherical glass nose. Delta-shape cruciform control surfaces at nose, indexed in line with large cruciform tail-fins
Guidance and Control: Infra-red homing guidance. Control by cruciform foreplanes
Warhead: High-explosive, weighing 25lb (11.4kg)



Above: Sidewinder AIM-9L on a US Navy F-4 Phantom II.

Length: 9ft 3.5in (2.83m) *9ft 5in (2.87m)*
Body diameter: 5in (0.13m)
Span of tail-fins: 1ft 10in (0.56m) *2ft 0.75in (0.63m)*
Launch weight: 159lb (72kg) *190lb (86kg)*
Max speed: Mach 2.5
Max range: 2 miles (3.35km) *4.35 miles (7km)*

Development and Service
Sidewinder is one of the most-produced of all airborne missiles. Firing trials began on 11 September 1953, and more than 80,000 of the basic infra-red homing AIM-9Bs were manufactured subsequently by Ford Aerospace and General Electric for the US services, the Royal Navy, Royal Canadian Navy, Royal Netherlands Navy, the Air Forces of nine NATO nations, Australia, Japan, the Philippines Spain, Sweden, Taiwan and other countries. In addition, some 9,000 were produced under licence in Europe, by Bodenseewerk of Germany in association with companies in Denmark, Greece, the Netherlands, Norway, Portugal and Turkey.

The popularity of the initial Sidewinder resulted from the fact that it had fewer than two dozen moving parts and no more electronic components than the average home radio. A unique version of the Sidewinder family was the AIM-9C in that it had a Motorola semi-active radar guidance system to make it compatible with the all-weather combat capability of late-model F-8 Crusader fighters of the US Navy. All other Sidewinders employ infra-red guidance. The AIM-9D, produced mainly by Raytheon for the US Navy and UK, introduced a Rocketdyne Mk 36 Mod 5 motor for increased speed and range, a new guidance unit and warhead, and could be distinguished by its tapering nose and larger-chord canards. These components were common to the AIM-9C. The AIM-9E, produced by Ford Aerospace for the USAF, was a converted B with improved guidance and control. Approximately 5,000 were produced. Raytheon's AIM-9G was similar to the D but with improved target acquisition and lock on, for the US services. To overcome limitations experienced in Vietnam, the US Navy's AIM-9H, in production since 1971, is a development of the G for 'dogfighting', with solid-state guidance for improved reliability decreased minimum effective range and faster angle-tracking rates.

The AIM-9J, produced by Ford Aerospace for the USAF, incorporates improved manoeuvring ability. A later version of AIM-9J, designated AIM-9P, includes improved lethality due to improved fusing and a reduced smoke rocket motor. AIM-9N is the designation of the FMS version of AIM-9P. The AIM-9L, a joint US Navy and US Air Force developed Sidewinder produced by Raytheon and Ford Aerospace, features improved manoeuvrability, increased acquisition envelope, and increased lethality due to fuse and warhead improvements. Under development by Ford Aerospace for proposed use by the USAF is the AIM-9J+ (J-3) incorporating solid-state electronics, improved fusing and increased acquisition envelope. Under joint development by the US Navy and USAF is the AIM-9M with improved capabilities which include increased counter-countermeasures, improved background discrimination and closed cycle cryogenics. Reliability and value engineering improvements are also proposed and a reduced smoke rocket motor is in development.

Siren (SS-N-9)

USSR

Surface-to-surface missile. In service.

Guidance and Control: Autopilot with possible radio command. Active radar terminal homing
Warhead: High-explosive
Range: 46-170 miles (75-275km)

Development and Service
The SS-N-9 is carried by the Nanuchka class corvettes, each having a triple launcher on each side of the bridge. Deployment began in about 1968.

Skean (SS-5)

USSR

Intermediate-range ballistic missile. In service.

Powered by: Liquid-propellant rocket motor
Airframe: Cylindrical body of constant basic diameter, with flared skirt at tail and blunted conical nose-cone. No fins or wings
Guidance and Control: Probably inertial
Warhead: Thermonuclear 1 megaton yield
Length: 75ft 0in (23.0m)
Max body diameter: 8ft 0in (2.40m)
Max range: 2,300 miles (3,700km)

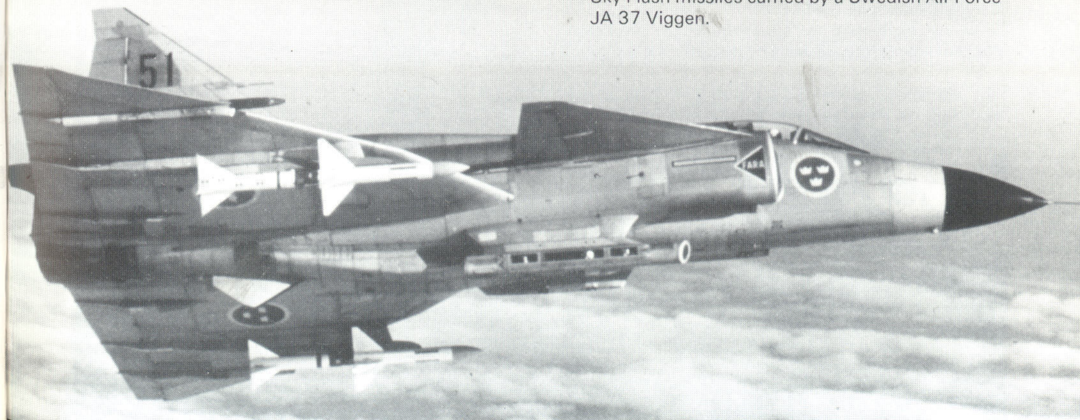
Development and Service
Although infinitely more formidable than V-2, 'Skean' can probably be regarded as the ultimate postwar development of the basic concept of that wartime German missile. It appears to be a scale-up of the 'Shyster-Sandal' family, with storable liquid-propellant rocket engine, and has a thermonuclear warhead of one megaton yield.

'Skean' was first deployed in 1961 and was included in a parade through Moscow in November 1964. Subsequently Soviet films showed missiles of this type housed in underground silo launchers, but deployment seems to have been limited, with no more than 100 'Skeans' operational. Like 'Sandal', these were probably divided between Russia's missile forces aimed at Western Europe and China and Japan. Many 'Skeans' have already been replaced by SS-20s, and it is expected that all 'Skeans' will be superseded shortly.

Sky Flash

UK

Sky Flash missiles carried by a Swedish Air Force JA 37 Viggen.



Air-to-air missile. In production and service.

Prime contractor: British Aerospace Dynamics Group
Guidance and Control: Semi-active radar homing
Length: 12ft (3.66m)
Max body diameter: 8in (0.203m)
Wing span: 3ft 4.25in (1.02m)
Launch weight: 425lb (193kg)
Cruising speed: Mach 4
Max range: 31 miles (50km)

Development and Service
Sky Flash (XJ521) is a medium-range all-weather missile based on the American Raytheon AIM-7E Sparrow. It is a 'boost and coast' missile, with a new semi-active radar homing head designed by Marconi Space and Defence Systems Ltd, for all-sector attack against subsonic and supersonic aircraft, flying faster and higher or lower than the launch aircraft. It can be launched at subsonic or supersonic speeds and is fitted with a new fuse system developed by EMI Electronics Ltd, which helps to give it a high single-shot kill capacity against targets at any altitude. Full development and initial production were covered by Ministry of Defence contract in February 1974. The first five firings, in 1975-76, proved highly successful, even against 'glinting' jet targets. Firing trials were completed in December 1977. Sky Flash missiles will eventually arm RAF Panavia Tornado F Mk 2s, and have been ordered by the Swedish Air Force for its Saab JA 37 Viggens under the designation RB71. Successful launches have also been made from the General Dynamics F-16 fighter.

SLAM

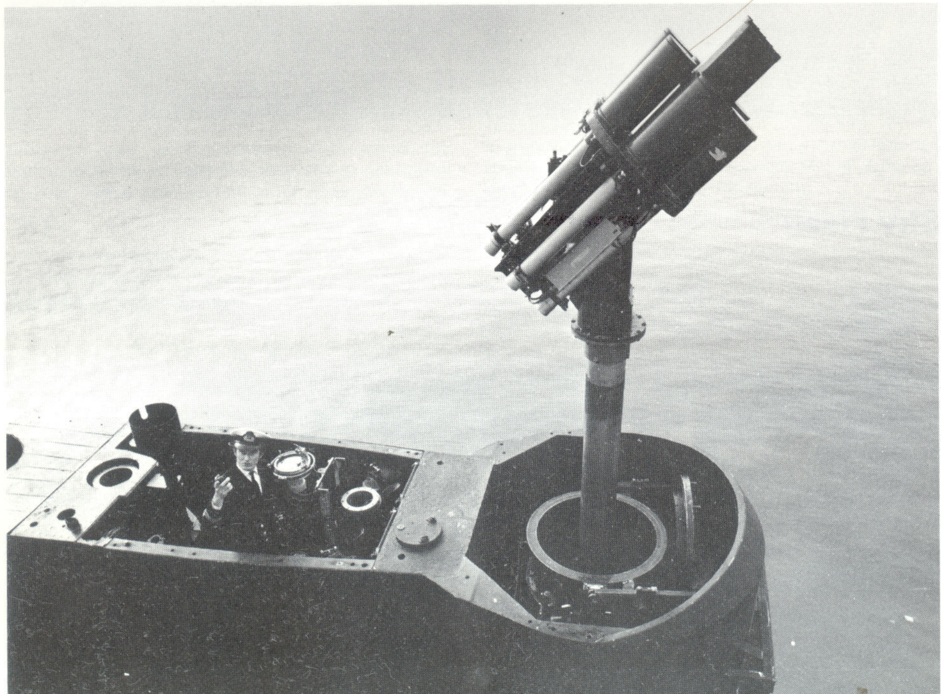
UK

Ship-launched missile system. In service.

Prime contractor: Vickers Ltd, Shipbuilding Group

Development and Service
The acronym SLAM signifies surface-launched air missile system. In its initial form, the weapon system was originally developed for compatibility with the Oberon class of submarines; but SLAM can be retro-fitted or built into almost any type of underwater or light surface craft for short-range defence against aircraft, helicopters and enemy surface craft. It consists of a cluster of six Blowpipe missile launchers surrounding an electronic package on a pylon mounting. Equipment in the electronic package includes a TV camera, gyro-stabiliser and some missile control equipment. After launch, each missile is guided by joystick by an operator in the ship's control room, who keeps both missile and target centred on a TV monitor. Preliminary trials of SLAM had been completed by January 1970. Sea trials on the submarine *Aeneas* were successfully completed by the end of 1972. The three Vickers Type 206 submarines of the Israeli Navy have provision for SLAM.

Below: SLAM installation on board HMS *Aeneas*.



Snapper (AT-1)

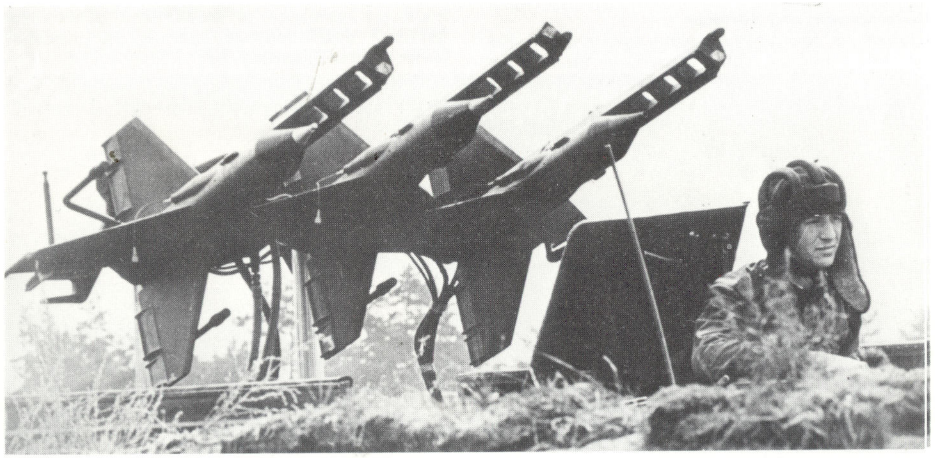
USSR

Light anti-tank missile. In service.

Powered by: Solid-propellant rocket motor
Airframe: Short cylindrical body with conical nose-cone. Rear-mounted cruciform wings of delta shape, each with one or two vibrating spoilers mounted in its trailing-edge
Guidance and Control: Wire-guided and spin-stabilised. Control by means of spoilers
Warhead: Hollow charge, weighing 11.5lb (5.25kg), with contact fuse. Capable of penetrating 13.7in (35cm) of armour
Length: 3ft 8.5in (1.13m)
Body diameter: 5.5in (0.14m)
Wing span: 2ft 5.5in (0.75m)
Launch weight: 49lb (22.25kg)
Cruising speed: 120mph (323km/h)
Range: 1,640-6,560ft (500-2,000m)

Development and Service
Like 'Guideline' and 'Atoll', this is one of the better-known Soviet missiles because examples were captured by the Israeli Army during the 1967 June War. 'Snapper' is a first-generation anti-tank weapon, similar in configuration to Western missiles such as the Nord SS.10 and MBB Cobra. In its initial operational form, as captured by Israel, 'Snapper' was carried on a quadruple launcher by a GAZ-69 jeep-type vehicle. Control was by joystick, and the operator kept the missile aligned on target during flight with the aid of tracking flares mounted on two of the wings. Standard transport/launch vehicle in recent years has been the armoured, amphibious BRDM, which carries a retractable three-round launcher. Although old and being replaced by the 'Sagger' missile, 'Snapper' continues to serve with the Warsaw Pact countries and with Afghanistan, Egypt, Mongolia, Syria and Yugoslavia.

Below: 'Snapper'.



Spada

Italy

Short-range surface-to-air missile system. Under development.

Prime contractor: Selenia Industrie Elettroniche Associate SpA

Development and Service
Spada is an all-weather, quick-reaction missile system designed for point and area defence against low and very low-altitude formations of aircraft or sequential attack. It consists of Aspide missiles, a 4-cell missile launcher, tracking and illuminating radar, search and interrogation radar and control unit. All elements of this system are air and ground transportable. Spada is in an advanced phase of development. A land mobile Spada system is also under development and comprises three vehicles; a search and tactical control unit, a fire control and guidance unit and a launch unit with an eight-cell Aspide missile launcher.

Sparrow (AIM-7)

USA

Long-range air-to-air missile. In production and service.

Data: AIM-7F
Prime contractor: Raytheon Company
Powered by: Hercules Mark 58 Mod 0 solid-propellant rocket motor
Airframe: Slim cylindrical body with pointed ogival nose. Pivoted cruciform delta wings mid-way along body, indexed in line with cruciform delta tail-fins
Guidance and Control: Raytheon semi-active Doppler radar homing system. Control by movable wings
Warhead: High-explosive continuous-rod warhead, weighing 88lb (40kg), actuated by proximity or contact fuse
Length: 12ft 0in (3.66m)
Body diameter: 8in (0.20m)
Wing span: 3ft 4in (1.02m)
Launch weight: 500lb (227kg)
Max speed: over Mach 3.5
Max range: 28 miles (44km)

Development and Service

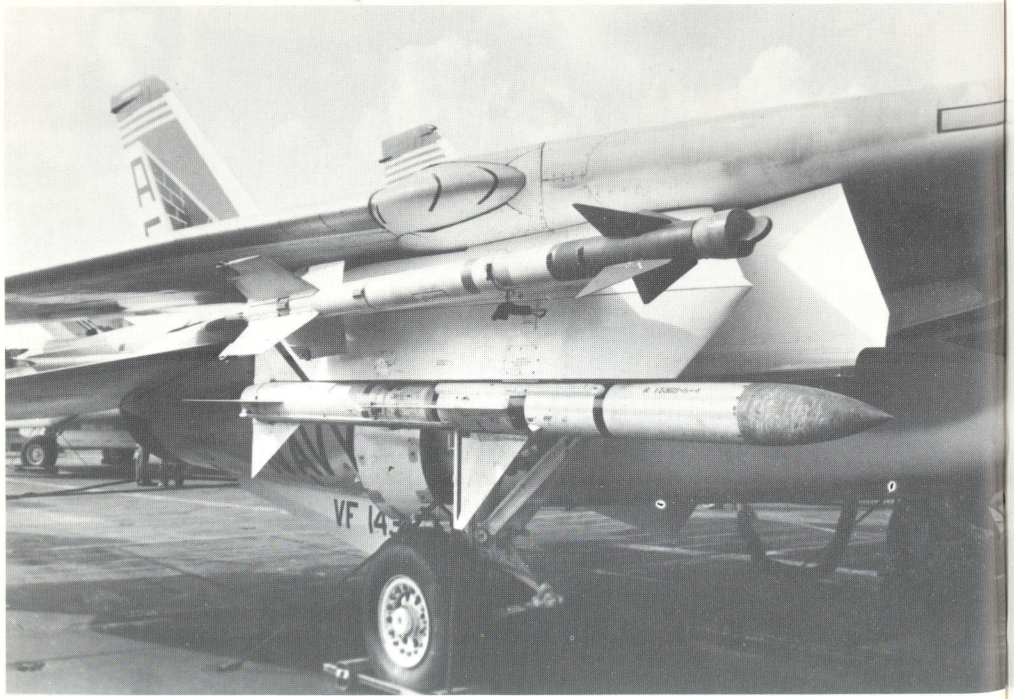
Sparrow is one of the most important missiles currently in service with the NATO air forces, their allies and friends. It is a large, all-weather all-altitude weapon, of which up to four can be carried by the McDonnell Douglas F-4 Phantom IIs of the USAF, US Navy, US Marine Corps, RAF, Royal Navy and other air forces. The Lockheed F-104S Starfighters of the Italian Air Force each carry two Sparrows, and similar weapons arm the McDonnell Douglas F-15 Eagle and Grumman F-14 Tomcat, America's primary fighters. Mitsubishi is producing more than 600 in Japan, for aircraft of the Japan Air Self-Defence Force, and a version known as Sky Flash is in production by British Aerospace for the RAF.

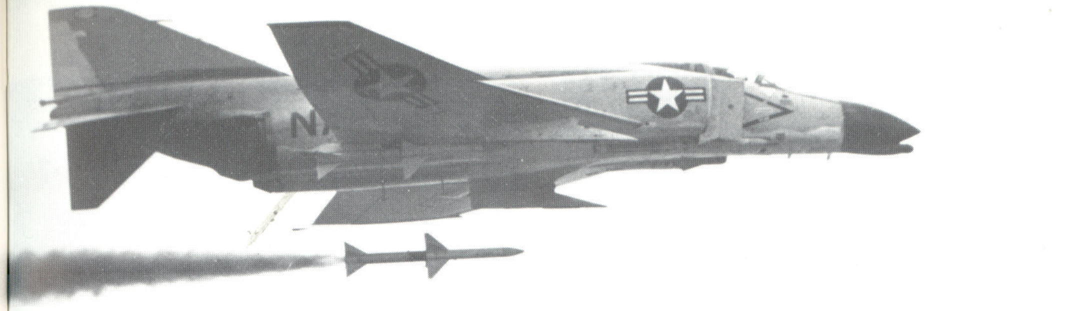
The basic current version of Sparrow is the AIM-7F, an advanced model with improved manoeuvrability, making it an efficient 'dogfight' weapon as well as a good medium-range missile with all-aspect capability. It has many new features, including a Hercules rocket motor of larger size than the Rocketdyne Mk 38 Mod 2 fitted to earlier versions, a new Doppler guidance system with smaller solid-state seeker, and a heavier repositioned warhead.

A total of 34,000 AIM-7C, D and E Sparrows was built. General Dynamics and Raytheon are expected to produce 9,804 AIM-7Fs for the US Navy and 9,150 for the USAF. By 1981, it is hoped to equip these missiles with a new monopulse seeker to enhance lookdown performance and provide improved resistance to clutter and ECM. Ship-launched adaptations of Sparrow are described under the Sea Sparrow entry.

Below: Sparrow (lower) and Sidewinder (above) with nosecap.

Top right: Sparrow launch from a F-4 Phantom II.





Spartan (XLIM-49A)

USA

Long-range anti-ballistic missile. Deactivated and put in store in 1976.

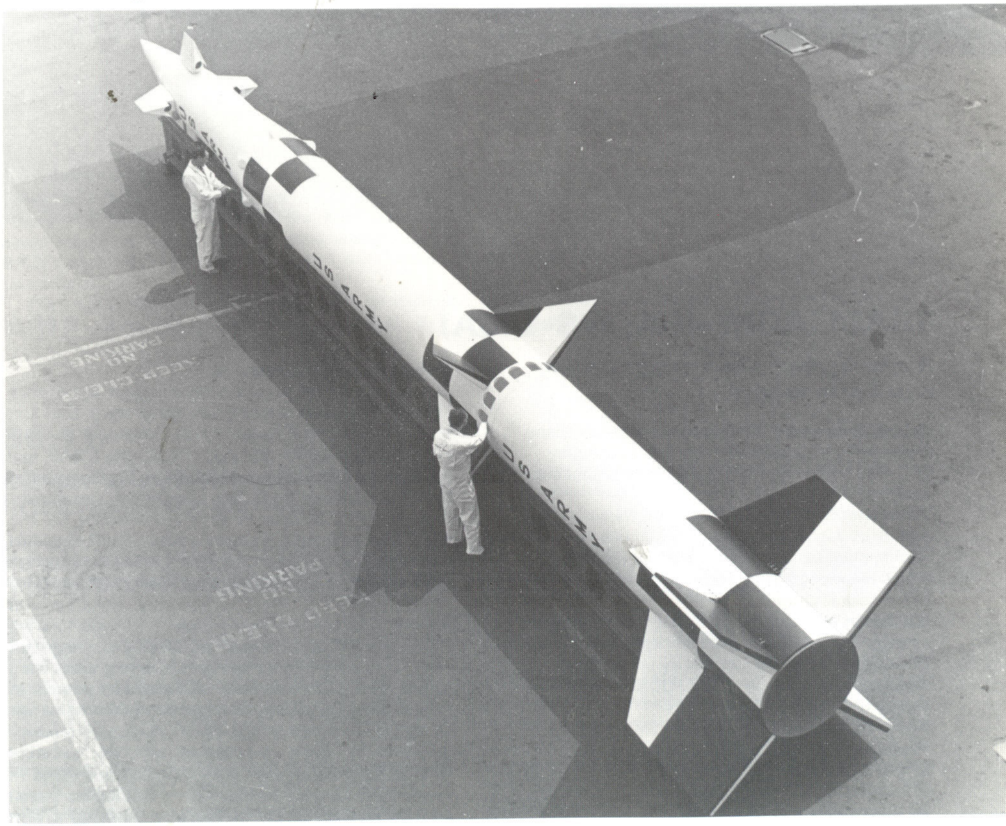
Prime contractor: Western Electric Company Inc
Warhead: Thermonuclear
Slant range: approx 465 miles (750km)

Development and Service

Spartan was the long-range partner to Sprint in America's Safeguard ABM defence system, of which only the Perimeter Acquisition Radar (PAR) remains functional, which was built to provide initial track data to alert firing units.

An improved Spartan has been studied, as a higher performance missile with a quicker reaction time, making it suitable for use against depressed trajectory ICBMs and low-altitude SLBMs, and with 'loiter' capability.

Below: Full-size mock-up of Spartan.



Sparviero

Italy

Anti-tank missile. Under development.

Prime contractor: Breda Meccanica, Bresciana SpA
Powered by: Solid-propellant rocket motor
Airframe: Cylindrical body with rounded nose. Cruciform flip-out foreplanes and tail-fins
Guidance and Control: Infra-red guidance system developed by Officine Galileo
Warhead: Hollow charge, weighing 8.8lb (4kg)
Length: 4ft 6.25in (1.38m)
Body diameter: 5.1in (0.13m)
Span: 1ft 9in (0.53m)
Weight of missile: 36.4lb (16.5kg)
Weight of system: 152lb (69kg)
Range: 250-9,850ft (75-3,000m)

Development and Service

The tube-launched Sparviero (Hawk) is a third generation anti-tank missile, being developed for the 1980s. It also has surface-to-surface and air-to-surface (helicopter-launched) capabilities. It is reported to be the first missile of its type to do away with trailing wires for transmission of guidance command signals.

Sprint

USA

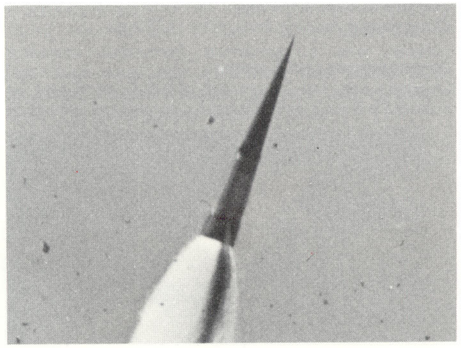
Close-range anti-ballistic missile. Deactivated and put in store in 1976.

Prime contractor: Martin Marietta Corporation
Warhead: Nuclear
Range: approx 25 miles (40km)

Development and Service

This close-range weapon was developed to provide a 'last-ditch' defence against enemy ICBMs which eluded Spartans in America's Safeguard Ballistic Missile Defence (BMD) system. An improved version of Sprint, 'Sprint II', was also developed.

ABM research and development are continuing in the USA, despite the deactivation of the Safeguard system.



SRAM (AGM-69A; WS-140A)

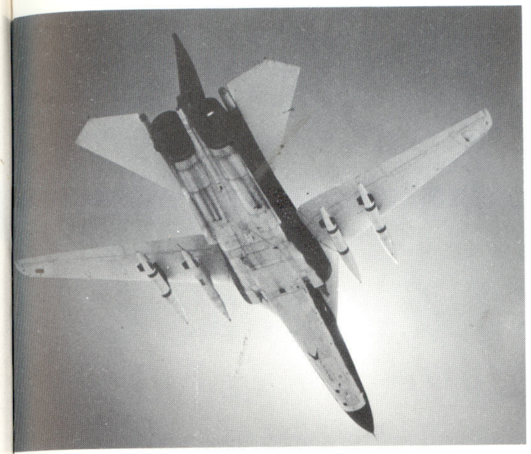
USA

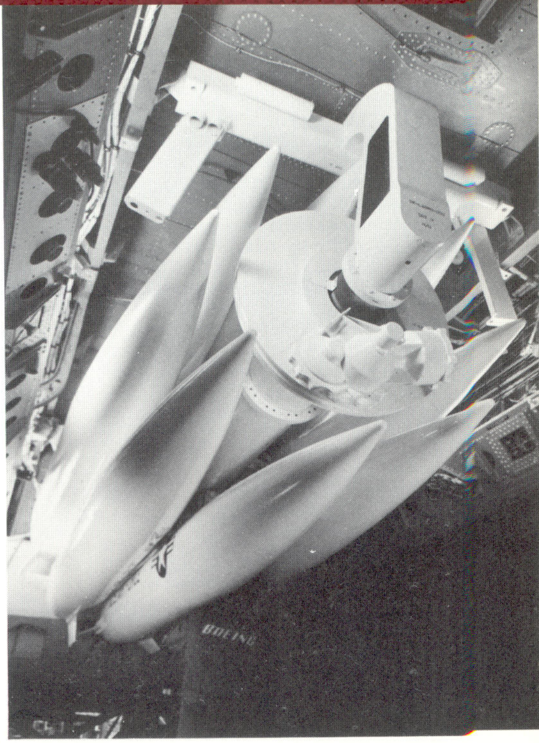
Air-to-surface short-range attack missile. In service.

Prime contractor: Boeing Aerospace Company
Powered by: Lockheed Propulsion Company LPC-415 restartable two-pulse solid-propellant rocket motor
Airframe: Body of circular section, tapering at tail and fitted with long ogival pointed nose-cone. Three equi-spaced tail control surfaces around nozzle, which is faired off by a destructible tail-cone when the missile is carried externally
Guidance and Control: KT-70 inertial guidance system, with terrain avoidance capability, by Kearfott Division of Singer Co. Control by tail surfaces
Warhead: Nuclear, W-69 of 200 kiloton yield
Length: 14ft 0in (4.27m)
Body diameter: 1ft 5.5in (0.445m)
Weight: approx 2,230lb (1,010kg)
Cruising speed: over Mach 3
Max range: 100 miles (160km) in 'high mode' 35 miles (55km) in 'low mode'

Development and Service

Boeing started work on a short-range attack missile (SRAM), to extend the effective life of the B-52G and H versions of their Stratofortress strategic bomber, in December 1963. By July 1965, the USAF had formulated a need for a weapon of this type; after studying tenders from five competing companies, they selected Boeing as prime contractor for the AGM-69A (Weapon System 140A). Each B-52G/H can carry 20 SRAMs, of which 12 are mounted as three-round underwing clusters and eight go on a rotary launcher in the aft bomb-bay, together with four Mk 28 thermonuclear weapons. The swing-wing FB-111As of two Strategic Air Command wings can each carry six SRAMs, four on swivelling underwing pylons and two internally. Development launches from both types of aircraft began in 1969. In one test by a USAF crew from a B-52 in 1970, two missiles launched in rapid succession hit two separate targets. Production was authorised by the USAF in January 1971, and deployment to B-52 units began on 4 August 1972. SRAM was also expected to arm the Rockwell International B-1 supersonic bomber until it was cancelled in 1977.





Above left: SRAMs under the wings of an FB-111A.

Above: SRAM eight-round rotary launcher.

Key to the accuracy of SRAM is the information fed into its guidance system before launch. The Guidance and Controls Division of Litton Industries is responsible for the B-52 inertial measurement unit; Autonetics Division of Rockwell International for the B-52/FB-111 aeroplane computer; IBM for modifying the B-52 bomb-nav system. The missile can fly 'dog-leg' courses to elude the defences, is unaffected by enemy ECM and appears no larger than a machine-gun bullet on radar screens. Its range is said to vary from 100 miles (160km) at high altitude to 35 miles (55km) at low level, at high supersonic speed.

All 1,500 SRAMs ordered had been delivered by August 1975 to the 18 Strategic Air Command bases scheduled to receive the missile, equipping 17 B-52 and 2 FB-111A wings. About 1,400 remain operational.

The improved AGM-69B SRAM-B was cancelled in 1977 after the Rockwell International B-1 strategic bomber programme was abandoned, which was expected to be the carrier aircraft. However, SRAM-As are to be upgraded using a new Thiokol rocket motor and improved electronics including alterations to the computer to increase the missile's flight profile capability.

SS.11

France

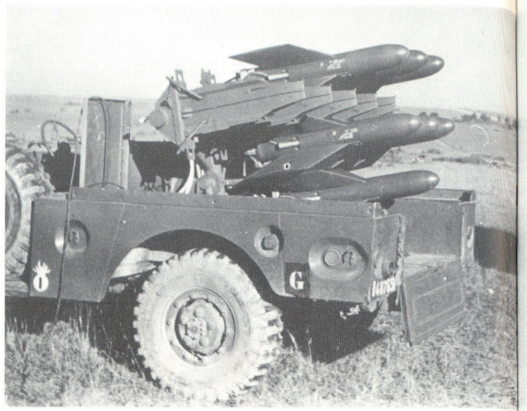
Surface-to-surface battlefield missile. In production and service.

Prime contractor: Nord-Aviation/Aérospatiale, Division Engins Tactiques
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical body, with sweptback cruciform wings and rounded ogival nose
Guidance and Control: Wire guidance by line-of-sight command via operator's joystick controller. Spin-stabilised. Control by deflection of the sustainer efflux
Warhead: Alternative Type 140 AC armour-piercing able to penetrate 24in (600mm) of steel, Type 140 AP02 high-explosive which will penetrate 0.4in (10mm) of steel plate at full range, or Type 140 AP59 high-fragmentation anti-personnel type with contact fuse. Inert type for practice available
Length: 3ft 11in (1.20m)
Body diameter: 6.5in (0.164m)
Wing span: 1ft 7.5in (0.50m)
Launch weight: 66lb (29.9kg)
Cruising speed: 360mph (580km/h)
Range limits: 1,650-9,840ft (500-3,000m)

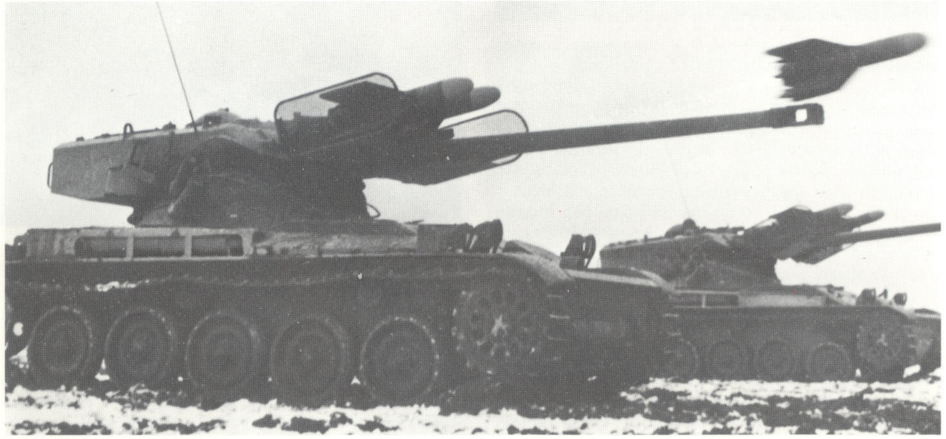
Development and Service

Nord-Aviation developed this very effective tactical missile as a follow-on to its success with the SS.10 and Entac. Production has been continued by Aérospatiale. It is used by all three French services and by the armed forces of 20 other countries including the USA and UK.

Being larger than the SS.10, the SS.11 is fired normally from ground vehicles and light naval vessels, including hovercraft; but it can be dismounted for operation from a ground launcher by mountain combat, airborne and coastal defence forces. In action, the operator follows both the target and the missile by means of a magnifying optical sight, and guides the missile to impact by means of a control joystick. Tracking is facilitated by flares on the rear of the missile. When the missile is installed on a ship a special stabilised sight is used. The standard production version since 1962 has been the SS.11 B.1 (and AS.11 B.1) with transistorised firing equipment. The Harpon is similar except for its use of TCA guidance. (See AS.11 for production totals).



Right: SS.11s on a jeep launcher.



Below: SS.11 launch.

SS.12

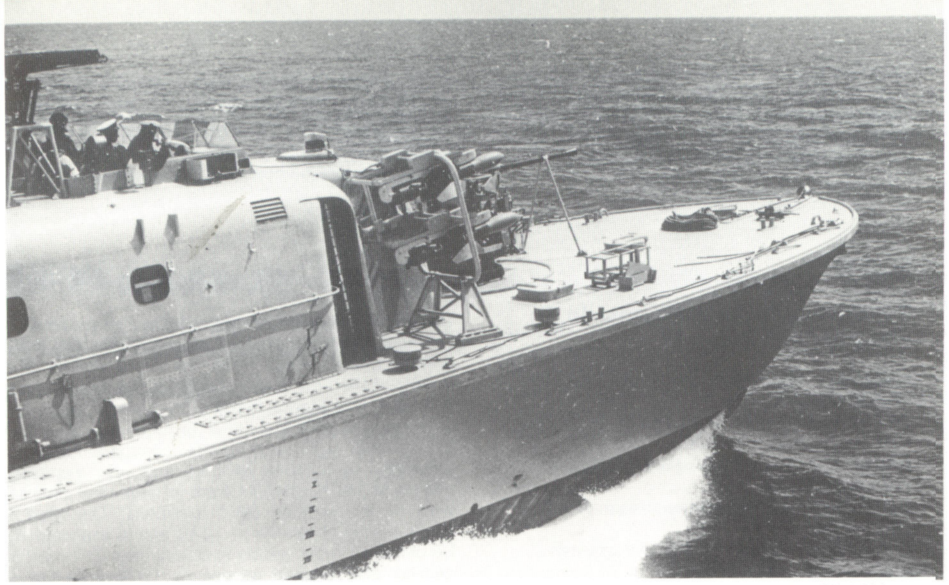
France

Surface-to-surface tactical missile. In service.

Prime contractor: Nord-Aviation/Aérospatiale, Division Engins Tactiques
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical body with mid-positioned cruciform wings and bulged ogival nose. Two sustainer nozzles aft of wings, on opposite sides of body
Guidance and Control: Wire-guided by command line-of-sight. Manual infra-red missile tracking. Spin-stabilised. Control by sustainer jet deflection
Warhead: Alternative OP.3C armour-piercing warhead capable of penetrating more than 1.5in (40mm) of steel, shaped charge for anti-tank use, or pre-fragmented anti-personnel type, each weighing 66lb (30kg)
Length: 6ft 1.9in (1.87m)
Body diameter: 7in (0.18m)
Wing span: 2ft 1.5in (0.65m)
Launch weight: 167lb (75kg)
Cruising speed: 425mph (685km/h)
Max range: 19,650ft (6,000m)

Development and Service

By scaling up their very successful SS.11 Nord-Aviation (now Aérospatiale) were able to produce the still-compact SS.12 with a warhead about four times as heavy as that of the smaller missile. This makes it suitable for use against fortifications as well as all types of vehicles, including tanks and ships. The missile uses optical line-of-sight command guidance, through trailing wires. Another derivative is the 'marine' SS-12M, which was first demonstrated to naval officers of eight countries from the coastal patrol boat *La Combattante*, off Toulon, on 15 June 1966. On that occasion, two SS.12Ms were fired from a lightweight launcher, with self-contained optical sighting, guidance and control equipment, against a moving target nearly 3.5 miles (5.5km) away. Both impacted the target within 3ft (1m) of dead centre and the same distance above the waterline. First operational fast patrol boats to be fitted with this weapon were three Vosper Thornycroft Susa class patrol boats of the Libyan Navy. Each carries two four-round launchers able to mount SS.12Ms for combat use or SS.11s for training. Orders for 8,287 AS.12/SS.12 missiles had been received by January 1979.



Above: Susa class patrol boat carrying SS.12M missiles.

SS-16

USSR

Intercontinental ballistic missile. In service.

Powered by: Solid-propellant motor
Airframe: Three-stage missile
Guidance and Control: Inertial
Warhead: Probably of more than one megaton yield. MIRV capability
Length: 65ft 8in (20m)
Range: More than 5,000 miles (8,000km)

Development and Service

SS-16s were expected to replace the SS-13s deployed, although it has been reported that deployment has not yet been undertaken. This missile uses an advanced navigation guidance system and a computer-operated post-boost vehicle but it is believed that initial deployment was planned only with a single re-entry vehicle. A land-mobile version could also be available. Test firings began in 1972.

SS-17

USSR

Intercontinental ballistic missile. In production and service.

Powered by: Liquid-propellant motors
Airframe: Two-stage missile
Guidance and control: Inertial
Warhead: MIRV version with four warheads of up to one megaton each. Mod 2 version has single large warhead
Length: approx 78ft 9in (24m)
Body diameter: approx 8ft 2in (2.5m)
Range: estimated at over 6,200 miles (10,000km)

Development and Service

Successor to the SS-11 (along with the SS-19), this missile has a far greater throw weight than the older missile and improved survivability. It has been tested with a single large re-entry vehicle and with four MIRVs. The single re-entry vehicle, with the accuracy given by the post-boost vehicle, permits operation against hard targets. It is uncertain whether operation with the MIRVs is sufficiently accurate to destroy hard targets. This missile employs high-speed re-entry vehicles, and guidance refinement may confer a counter-force capability. The MIRVed SS-17 became operational in 1975. It is 'cold launched', being popped out of its silo by a gas generator before its first-stage motors are fired. This reduces damage to the silo, permitting reload. At least 100 were thought to be deployed by 1979, most with MIRVed capability.

SS-18

USSR

Intercontinental ballistic missile. In production and service.

Powered by: Liquid-propellant rocket motor
Airframe: Two-stage missile
Guidance and Control: Inertial guidance. Control probably by gimballed nozzles
Warhead: Mod 1 has single re-entry vehicle of 25-50 megaton yield
Mod 2 has eight MIRVed warheads each of 1-2 megaton yield
Mod 3 has single re-entry vehicle with greater accuracy
Length: approx 118ft 2in (36m)
Body diameter: approx 9ft 10in (3m)
Range: approx 7,450 miles (12,000km)

Development and Service
Designed to replace the SS-9, this missile has 30-50% greater throw weight than the SS-9 and is the largest of the new Soviet ICBMs. It has been tested in Mod 1 and Mod 3 forms with a single large re-entry vehicle and in Mod 2 form with a bus-type system with eight large MIRVs. It has a hard-target capability even when MIRVed and was deployed initially in 1974 in Mod 1 form in large new silos as well as in modified SS-9 positions. The Mod 2 version entered service in 1976 and is expected to be deployed most widely in due course. The Mod 3 version also entered service in 1976 and has a greater range than the earlier Mods. More than 200 SS-19s were deployed by 1979. During a test launch in 1974, an SS-18 travelled 5,800 miles (9,330km). It is 'cold launched' like the SS-17.

SS-19

USSR

Intercontinental ballistic missile. In production and service.

Powered by: Liquid-propellant motor
Airframe: Two-stage missile
Guidance and Control: Inertial guidance. Control probably by gimballed nozzles
Warhead: Mod 1 has six MIRVed warheads each with one megaton yield
Mod 2 has been tested with single re-entry vehicle
Length: approx 88ft 7in (27m)
Body diameter: approx 9ft (2.75m)
Range: 6,200 miles (10,000km)

Development and Service
This 'hot-launched' missile is, with SS-17, replacing the SS-11 ICBMs, and about 300 SS-19s were thought to be deployed by 1979, mostly if not all with Mod 1 warheads. High-speed re-entry vehicles are employed and an uprated guidance is used. Test launches are thought to have started in 1973. The SS-19 became operational in 1975.

The SS-19 is reported to pose a serious threat to the survivability of the USA's Minuteman force. It has been reported that Congressional studies have indicated that a mere 15% of Soviet ICBMs could put out of action upwards of 75% of American missiles mainly due to the standard of Soviet guidance systems and their huge warheads. In contrast, current American missiles are reported to be capable of only a limited success against Soviet missile sites.

SS-20

USSR

Mobile intermediate-range ballistic missile. In service.

Powered by: Solid-propellant motors
Airframe: Two-stage missile
Guidance and Control: Inertial guidance. Control possibly by fluid injection into nozzle
Warhead: Three MIRVs each of 600 kiloton yield
Length: 52ft 6in (16m)
Body diameter: approx 5ft 9in (1.75m)
Range: at least 3,420 miles (5,500km)

Development and Service
The SS-20 utilises the first two stages of the SS-16 ICBM and has a MIRVed payload. It is therefore far more formidable than the 'Sandal' and 'Skean' missiles it is replacing and poses an increased throw-weight that faces Western Europe. It is a mobile system launched from a tracked vehicle with reload capability. It has been reported that as many as 400 SS-20 launch vehicles, with a higher number of missiles (and reloads) are expected to be deployed initially. About 100 are already operational.

SS-21 and SS-22

USSR

Surface-to-surface bombardment missiles. In production and service.

Development and Service
These are two new guided battlefield missiles. Both are already in service with the Soviet forces and possibly other Warsaw Pact nations. SS-21s are expected to supplement 'Frog' missiles and later supersede them. The SS-22 will supersede the 'Scaleboard' missile system. It is thought to be suitable for nuclear, chemical and conventional warheads, and a range of 500 miles (805km) has been reported. It has also been said that SS-22 is intended for conventional attacks on hardened aircraft shelters.

SS-X-?s

USSR

Intercontinental ballistic missiles. Under development.

Development and Service
It has been reported that four new ICBMs are currently under development in the Soviet Union for possible deployment in the mid-1980s. No further information is available.

SSBS (S-2)

France

Surface-to-surface ballistic missile. In service.

Prime contractor: Aérospatiale Division des Systèmes Balistiques et Spatiaux
Powered by: First stage SEP P.16 (Norma Type 902) solid-propellant motor
Second stage SEP P.10 (Norma Type 903) solid-propellant motor
Airframe: Two-stage missile. Cylindrical body of constant diameter, with basically cylindrical re-entry vehicle of smaller diameter
1st stage casing of maraging metal
2nd stage casing of Vascojet 1000. Cruciform tail-fins
Guidance and Control: Inertial guidance system. Each stage has four gimballed nozzles for control
Warhead: Nuclear, 150-kiloton yield
Length: 48ft 6.5in (14.80m)
Max body diameter: 4ft 11in (1.50m)
Launch weight: 70,327lb (31,900kg)
Max range: 1,960 miles (3,150km)

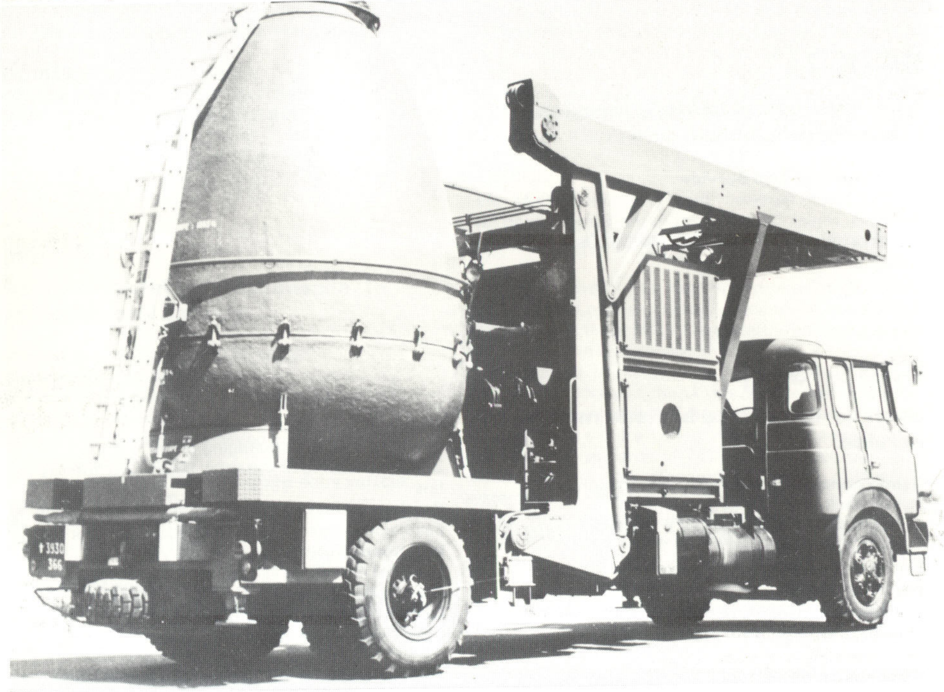
Development and Service

Two operational squadrons of the 1er Groupement de Missiles Stratégiques of the French Air Force deploy a total of 18 SSBS (sol-sol balistique stratégique) missiles. These are housed in underground silos on the Plateau d'Albion, east of Avignon in Haute Province, with fire control centres at Rustrel (Vaucluse) and Reilhannette (Drôme). The Saint-Christol Air Base (Apt) provides operational command, and technical and logistical support. The missiles are held at a state of readiness and are designed to be launched by the rapid remotely-controlled opening of the silo doors, without requiring any human action at the widely-dispersed launch areas.

It was intended originally to form three squadrons of SSBS missiles as the second-generation 'force de frappe', supplementing Mirage IVA strategic bombers of the French Air Force and with the French Navy's MSBS submarines to follow. Budget cutbacks compelled the deletion of one squadron. Deployment of the others started after the final S-02 prototype missile made a fully successful 1,550-mile (2,500km) flight towards the Azores, from a silo at Landes test centre on 24 June 1969. The first group became operational in the summer of 1971 and the second in 1972.

SSBS (S-3)

France



Above: SSBS warhead on its transporter/loader.

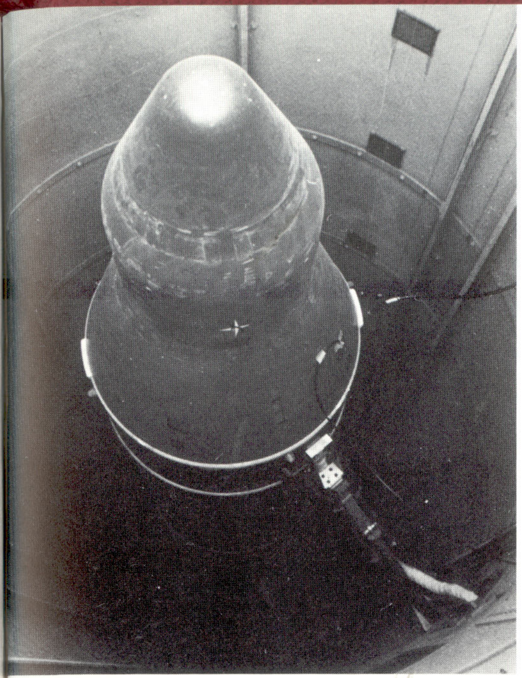
Surface-to-surface ballistic missile. Under development.

Prime contractor: Aérospatiale, Division des Systèmes Balistiques et Spatiaux
Powered by: First stage SEP P.16 (Type 902) solid-propellant motor
Second stage SEP P.6 (Rita II) solid-propellant motor
Guidance and Control: Inertial guidance system.
First stage has four gimballed nozzles
Second stage has a single nozzle with freon injection for control.

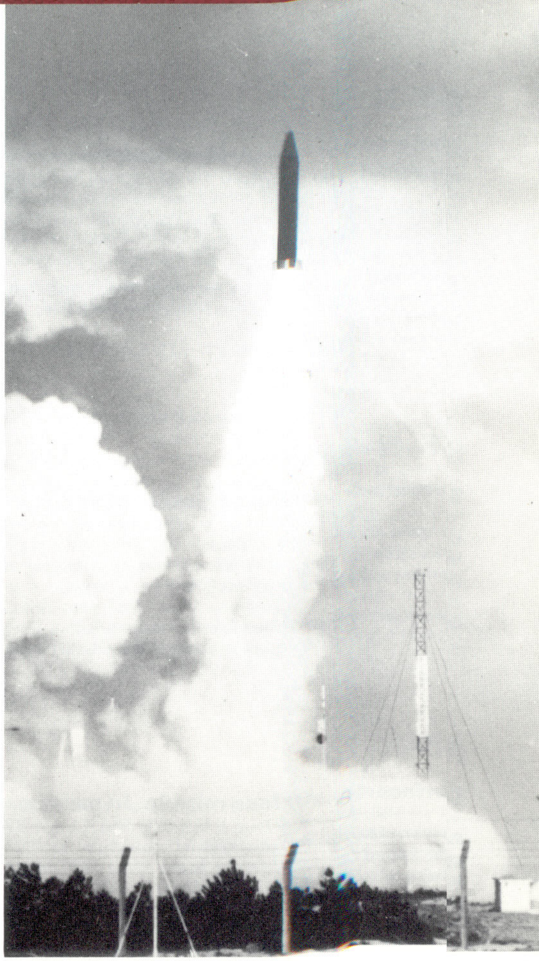
Warhead: Thermonuclear, one megaton yield
Length: 45ft 0in (13.72m)
Body diameter: 4ft 11in (1.50m)
Launch weight: 56,880lb (25,800kg)
Range: 1,864 miles (3,000km)

Development and Service

S-3 missiles will equip a new squadron of 9 silos in Haute Province, to be operational in 1980. The two S-2 squadrons will also be modernised to S-3 standard. The new missile will have improved penetration aids, as well as a thermonuclear warhead. The re-entry vehicle will be more advanced than that of the S-2, embodying subsystems to increase its resistance to ABM (anti-ballistic missile) nuclear attack.



Above: SSBS in its silo.



Right: SSBS (S-3) launch.

SS-N-7

USSR

Underwater/surface-to-surface missile. In service.

Powered by: Solid-propellant rocket motor
Warhead: High-explosive
Max speed: Mach 1.5
Range: 35 miles (56km)

Development and Service

This short-range missile is carried by the 15 nuclear-powered submarines of the Soviet Navy's 'Charlie I and II' classes, each of which has eight launch-tubes. It may also be carried by the 'Papa' class submarine, each with 10 launch tubes. Estimated range of this missile, which does not yet have a NATO reporting name, is 35 miles (56km). It has been suggested that it can be underwater launched. SS-N-7 is thought to use autopilot control with active radar homing. Deployment began in 1968.

SS-N-8

USSR

Underwater-to-surface ballistic missile. In service.

Powered by: Liquid propellant motors
Airframe: Two-stage missile
Guidance: Stellar-inertial
Warhead: Single re-entry vehicle with 1-2 megaton yield or three MRVs. A three MIRVed version has been tested
Range: 4,800-5,700 miles (7,725-9,200km)

Development and Service
This liquid-propellant SLBM, first deployed in 1973, is carried on the 'Delta I and II' classes of nuclear powered submarines, each submarine carrying 12 and 16 tubes respectively. By 1979, 15 'Delta I' class and eight 'Delta II' class submarines had been built. The SS-N-8 has a range considerably greater than that of the new American Trident 1 missile and its warhead has a bigger yield. The Soviet Union currently has 950 SLBM launchers.

SS-N-11

USSR

Surface-to-surface missile. In service.

Length: approx 22ft (6.7m)
Max speed: High subsonic
Range: approx 43.5 miles (70km)

Development and Service
SS-N-11 is the designation given to the missile, in its new launcher, carried on the Osa-2 patrol boats and a number of Soviet Kildin and Kashin class destroyers. It is also employed on the Indian Navy Vijaydurg corvettes, and Osa-2s of Iraq and Finland. Whether this is a new missile or an advanced version of 'Styx' is uncertain.

SS-N-12

USSR

Surface-to-surface missile. In service.

Powered by: Turbojet engine
Max speed: approx Mach 2.5
Range: approx 280 miles (450km) Could cruise at lesser speed for several times given range

Development and Service
Thought to have been developed as a replacement for 'Shaddock'. However, only the three Soviet aircraft carriers of the Kiev class are known to deploy the missile.

SS-N-13

USSR

Submarine-launched missile.

Guidance and Control: Cruise phase using satellite data. Terminal homing guidance
Warhead: Nuclear
Max speed: Mach 4

Development and Service
This missile could fit into the launch tubes of Soviet 'Yankee' class ballistic missile submarines. It may have been put into service as early as 1975. It has been suggested that its primary role is against ballistic missile submarines and aircraft carriers, but it clearly has other capabilities.

SS-N-14

USSR

Anti-submarine missile. In service.

Range: approx 18.5 miles (30km)

Development and Service
SS-N-14 is an anti-submarine weapon and serves on board the new Soviet Kara and Kresta II class cruisers, Krivak class destroyers, Kiev class aircraft carriers and Moskva class helicopter cruisers. It is a winged missile, based around a homing torpedo or nuclear depth charge. Fired from a ship-borne container or launcher, the missile flies over the probable submarine location and releases its warhead into the water.

SS-N-15

USSR

Underwater-to-underwater missile. In service.

Warhead: Nuclear
Range: approx 25 miles (40km)

Development and Service
Similar in concept to the US Subroc, the SS-N-15 is thought to be carried by the Soviet 'Victor II' class fleet submarines, the extra length of these over the earlier 'Victor' class indicating installation of the necessary launching tubes.

SS-NX-17

USSR

Underwater-to-surface ballistic missile. Under development.

Powered by: Solid-propellant motors
Guidance: Inertial
Warhead: Single re-entry vehicle. Has MRV/MIRV capability
Length: approx 36ft 3in (11m)
Body diameter: approx 5ft 5in (1.65m)

Development and Service
The SS-NX-17 was the first of two new Soviet SLBMs to undergo trials in recent years and the first Soviet SLBM to be powered by solid propellant motors. Testing of the missile started in 1975 and trials were underway in 1978 on board a 'Yankee' class submarine, the class of submarine on which it is expected to replace SS-N-6s. The SS-NX-17 is also equipped with a post-boost vehicle which is compatible with MRV capability, although reports have indicated that early trials centred on a single re-entry vehicle warhead.

SS-NX-18

USSR

Underwater-to-surface ballistic missile. Under development.

Powered by: Liquid-propellant motors
Warhead: MIRV with two or three re-entry vehicles
Length: approx 46ft 3in (14.1m)
Body diameter: approx 6ft (1.83m)
Range: approx 5,900 miles (9,500km)

Development and Service
Second of the new Soviet SLBMs, first test flown in 1975. It is believed to incorporate a more sophisticated guidance system than that in the SS-NX-17 and also has a post-boost vehicle for its MIRVed warhead. The first submarine launch of an SS-NX-18 took place in 1976. The missile is intended to replace SS-N-8s in 'Delta' class submarines and to equip the latest Soviet submarines of 'Delta III' and 'Typhoon' classes, of which many are being built.

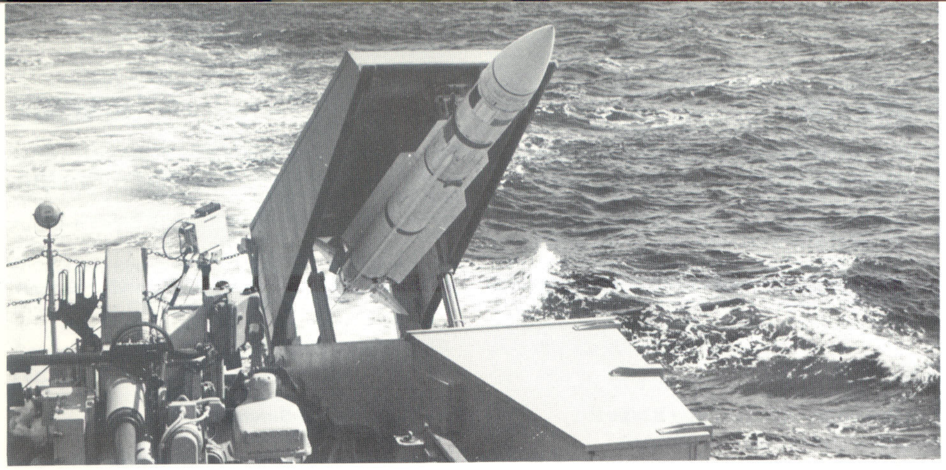
Standard ARM (AGM-78 and RGM-66D)

USA

Air-to-surface and surface-to-surface anti-radiation missile. In production and service.

Prime contractor: General Dynamics Corporation, Pomona Division
Powered by: Aerojet-General Mk 27 Mod 4 dual-thrust solid-propellant rocket motor
Airframe: Cylindrical body with pointed ogival nose. Cruciform long-chord narrow-span wings, with forward portions of much reduced span, indexed in line with cruciform tail control surfaces
Guidance and Control: Passive homing guidance system, using seeker head which homes on enemy radar emissions. Control by tail surfaces
Warhead: High-explosive
Length: 15ft 0in (4.57m)
Body diameter: 1ft 1.5in (0.343m)
Wing span: 3ft 6in (1.07m)
Launch weight: 1,356lb (615kg)
Max speed: Mach 2
Max range: 15.5 miles (25km)

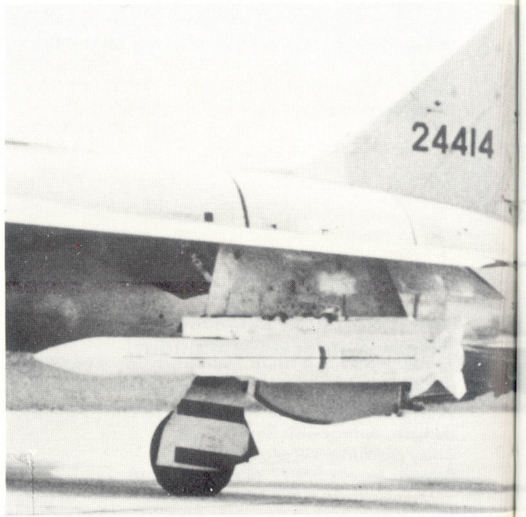
Development and Service
Design studies for this anti-radiation development of the RIM-66A Standard Missile 1 were started in 1966. Flight trials followed in 1967 and the weapon entered full production in 1968. Its purpose is to



home on and destroy enemy defensive and missile guidance radars. This must be possible in an ECM environment, and with the knowledge that an enemy operator will switch off a radar the moment he suspects that its signals are being picked up and used to provide target data for attack. As a result, a key item of support equipment is the Target Identification and Acquisition System (TIAS) carried by aircraft used as launch vehicles for Standard ARM. This is able to compute a trajectory for the missile on the basis of data already monitored in the event of the target radar being switched off.

Standard ARM (anti-radiation missile) is carried by the US Navy's A-6B/E and USAF's F-105 and F-4G. The original AGM-78A version used a standard Texas Instruments seeker head, as fitted to the Shrike missile. This was followed by an improved seeker developed by Maxson Electronics on the AGM-78B. Further-improved versions have been developed, with a seeker by GD/ Pomona, including the late production model designated AGM-78D. An impact marking device is fitted, to assist subsequent attacks on concealed targets.

The US Navy carried out firing trials of Standard ARM missiles from a special box-launcher mounted on a patrol gunboat during 1971, to evaluate the usefulness of the weapon system in a surface-to-surface role. This version remains in production and serves on guided missile destroyers and patrol combatant boats of the US Navy and vessels of foreign navies. The surface-to-surface version is designated RGM-66D. A truck-based coastal defence version of the RGM-66D has been produced.



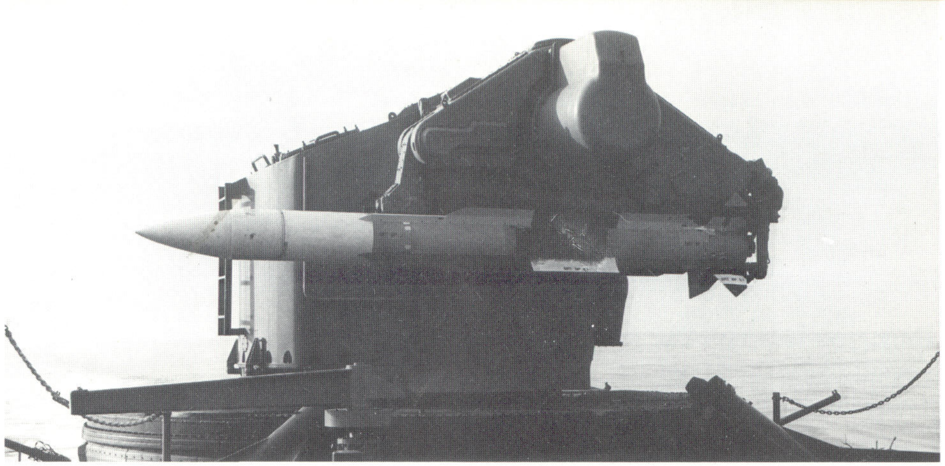
Top: Standard ARM launcher on a US Navy gunboat.

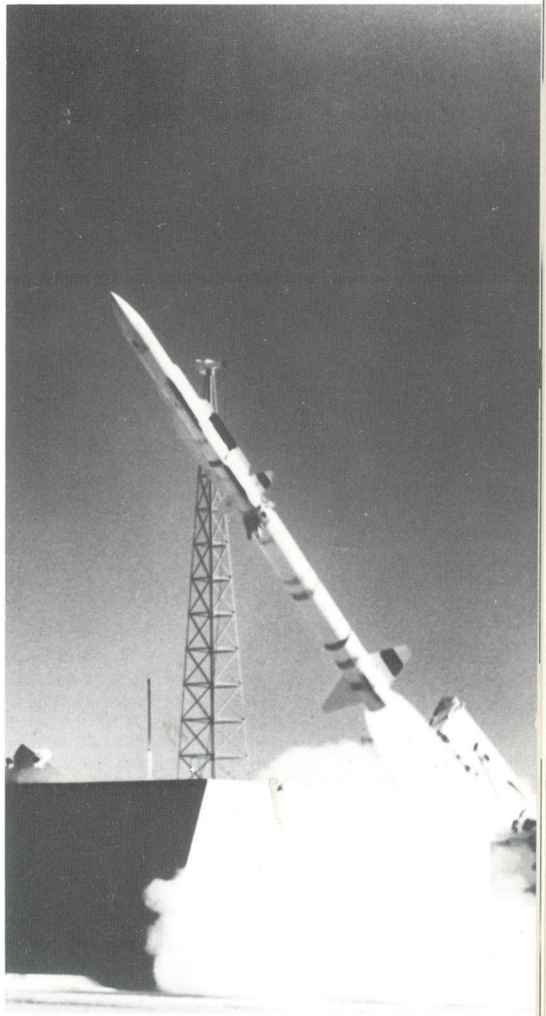
Above: AGM-78D version of Standard ARM carried by an F-105 Thunderchief.

Standard Missile (RIM-66/RIM-67A) USA

Supersonic ship-launched surface-to-air missiles. In production and service.

Prime contractor: General Dynamics Corporation, Pomona Division
Powered by: RIM-66 dual-thrust solid-propellant rocket motor
RIM-67A tandem two-stage solid-propellant rocket motors
All motors are produced by the Navy Ordnance System Command
Airframe: RIM-66A has cylindrical body with pointed ogival nose and cruciform long-chord narrow-span wings, with forward portions of much reduced span, indexed in line with cruciform tail control surfaces. RIM-67A second stage is externally similar to RIM-66A; first stage comprises a cylindrical booster with cruciform tail-fins indexed in line with second stage surfaces.





Above: Standard Missile 1 on the guided missile destroyer USS *Buchanan.*

Right: First guided flight of a Standard Missile 2.

Guidance and Control: General Dynamics/Pomona semi-active radar homing guidance. Control by tail surfaces
Warhead: High-explosive, with impact and proximity fuses
Length: RIM-66A 15ft 0in (4.57m)
RIM-67A 27ft 0in (8.23m)
Body diameter: 1ft 1.5in (0.34m)
Wing span: RIM-66A 3ft 5.75in (1.07m)
RIM-67A 5ft 3in (1.57m)
Launch weight: RIM-66A 1,300lb (590kg)
RIM-67A 2.337lb (1,060kg)
Max speed: RIM-66A over Mach 2
RIM-67A over Mach 2.5
Max range: RIM-66A 12.5 miles (20km)
RIM-67A 35 miles (56km)
Effective ceiling: 65,500ft (20,000m)

Development and Service

These two ship-launched missiles were developed by General Dynamics to replace their Tartar and Advanced Terrier, which the new weapons resemble externally. Simplicity and reliability result from the switch to solid-state electronics and an all-electric control system, with no pneumatics or hydraulics. The two configurations, the original RIM-66A and improved RIM-66B with Mk 56 Mod 0 motor medium-range Standard Missile 1 (MR) and RIM-67A extended-range Standard Missile 1 with Mk 30 Mod 1 booster (ER), are intended for use on cruisers and destroyers (MR) and frigates (ER). They are effective against both aircraft and anti-ship cruise missiles, down to very low levels, and have a surface-to-surface capability. About 70 ships of the US Navy and of Italy, Japan and Spain have been fitted with Standard Missile 1. Deployment was originally scheduled for completion by the mid-1970s, but missiles were still being produced in 1978. Standard Missile also forms the basis of the Standard ARM anti-radiation missile system. It will also be used in the initial Aegis defence system as the improved RIM-66C Standard Missile 2 (SM-2) (see Aegis). Again medium and extended-range versions are employed, with ranges of approximately 30 miles (48km) and 50 miles (80km) respectively. The SM-2 has a new semi-active monopulse terminal homing receiver, an inertial reference unit for mid-course guidance, a telemetry link for mid-course command guidance and a digital guidance computer. The SM-2 may also replace Advanced Terrier missiles on the majority of US vessels carrying the latter under the CG/SM-2 programme. Improvement programmes are also being initiated to enable Standard Missile to deal with future threats, whether from high-altitude supersonic cruise missiles or in other forms.

Stinger (XFIM-92A) and Alternate Stinger

USA

Shoulder-fired surface-to-air missile. Ready for production.

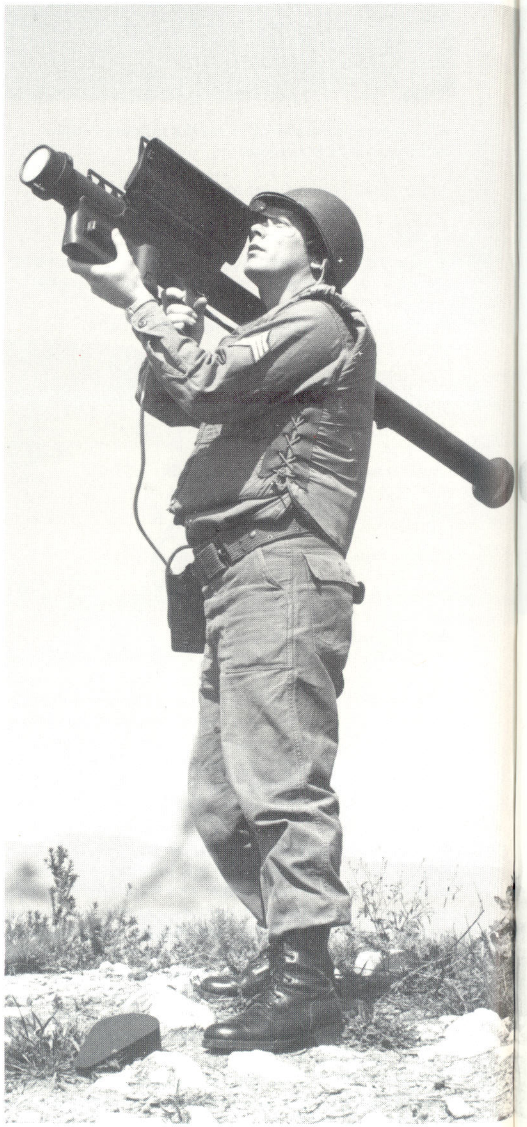
Data: Stinger
Prime contractor: General Dynamics Corporation, Pomona Division
Powered by: Atlantic Research dual-thrust solid-propellant rocket motor
Guidance and Control: Initial optical aiming with infra-red terminal homing
Warhead: High-explosive, with proximity fuse
Length: 5ft 0in (1.52m)
Launch weight: 29lb (13.4kg)

Development and Service

Stinger is an advanced version of Redeye one-man shoulder-fired air defence missile, and was originally known as Redeye II. It has been developed to supersede the earlier missile. The first guided test flight took place in January 1974. Six firings against manoeuvring targets were successfully made in early 1975 and the engineering development phase of Stinger was completed the same year. A decision whether to put Stinger into production was put off in 1976 and had not been concluded by 1978. Meanwhile studies of a new seeker with infra-red and ultra-violet sensitive detectors have been initiated.

Stinger uses an advanced infra-red guidance system which enables the gunner to attack the target from almost any angle, and includes an IFF system. The missile is launched from the sealed disposable tube that acts as its shipping and handling container.

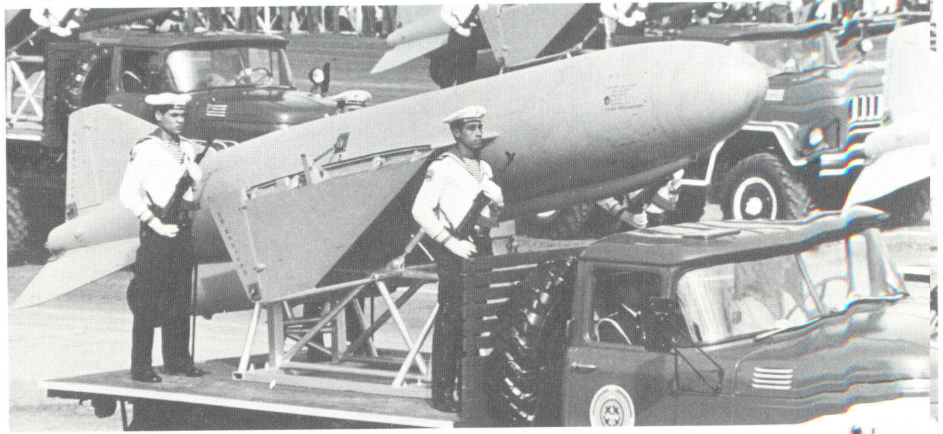
Under a $5 million contract, a version known as Alternate Stinger, with a laser guidance system, is being developed by Ford Aerospace and Communications Corporation's Aeronutronic Division. In this case, the operator tracks the target by means of a lightweight stabilised sight that aligns the laser beam along which the missile travels to the target. Ten Alternate Stingers were initially produced. Between July 1975 and July 1976 firing trials of Alternate Stinger resulted in hits on a stationary and a low-flying aerial target.

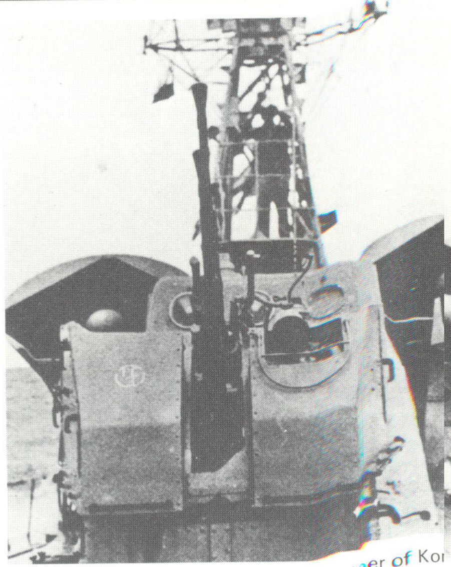


Right: Stinger.

Styx (SS-N-2)

USSR





Right: 'Styx' launchers on a Komar class patrol boat.

Surface-to-surface ship-launched cruise missile. In service.

Powered by: Nozzle for sustainer rocket motor in tail. Jettisonable solid-propellant booster, with downward-canted nozzle, under rear fuselage
Airframe: Aeroplane configuration. Circular-section body, with rounded nose-cone and tapered towards tail. Mid-set cropped-delta wings, with ailerons of almost full span. Three identical tail surfaces, each made up of a fixed fin and trailing-edge control surface
Guidance and Control: Cruise: Probably autopilot or radio command guidance
Terminal: Active radar system (sometimes reported as SS-N-2A and SS-N-2B versions respectively)
Control via ailerons and tail control surfaces
Warhead: High-explosive
Length: 20ft 6in (6.25m)
Max body diameter: 2ft 5.5in (0.75m)
Wing span: 9ft 0.25in (2.75m)
Launch weight: approx 6,615lb (3,000kg)
Max speed: approx Mach 0.9
Max range: 26 miles (42km)

Development and Service

This ship-to-ship weapon has the distinction of being one of the few modern surface-to-surface missiles of proven operational effectiveness. Its opportunity came on 21 October 1967, when the Israeli destroyer *Eilat* was detected sailing off Port Said, at a range of around 15 miles (24km). A series of 'Styx' missiles were launched from Soviet-built Osa class patrol boats of the Egyptian Navy, from the sheltered waters of the harbour. Some of these scored direct hits on the *Eilat*, which was sunk.

Each Osa class ship carries four 'Styx' missiles ready for launching in containers to each side of its rear deck. Komar class fast patrol boats are fitted with two similar containers. The Soviet Navy has a total of about 120 ships of the Osa class. Nearly as many more Osa class and a similar number of Kor class ships are operated by the navies of Alg Bulgaria, China, Cuba, Egypt, East Germany, Finla India, Indonesia, Iraq, North Korea, Poland, Roma Somalia, Syria, Vietnam and Yugoslavia. In addi 'Styx' missiles are built in China as CSS-N-1s arm patrol boats, frigates and destroyers. The Fin experimental missile boat *Isku* carries four 'S launchers, the Indian frigate *Talwar* carries th launchers and new North Korean boats carry missile.

A more sophisticated version of 'Styx' is belie to be carried on board Osa 2 boats. These mis are thought to be equipped with infra-red homin supplement the radar homing system. Howeve has been reported that this missile is known in West as SS-N-11 (qv).

Subroc (UUM-44A)

USA

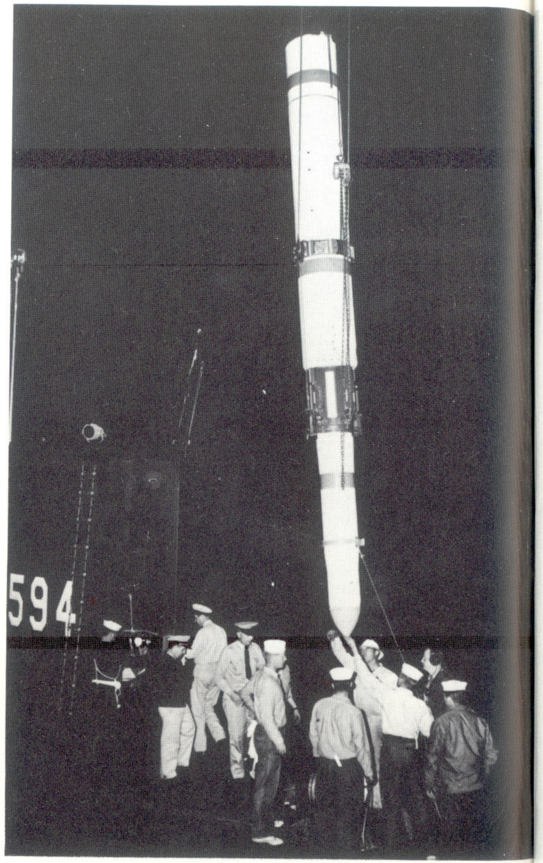
Underwater-to-underwater missile. In service.

Prime contractor: Goodyear Aerospace Corporation
Powered by: Thiokol solid-propellant tandem booster, with four nozzles embodying jet-deflection
Airframe: First stage comprises the Thiokol rocket motor in its cylindrical casing. The second stage is also cylindrical, with a short ogival nose-cone and four tail-fins, and is of smaller diameter than the first stage
Guidance and Control: Lightweight inertial guidance system. Control by thrust vectoring and aerodynamic tail-fins
Warhead: Nuclear depth bomb
Length: 20ft 6in (6.25m)
Max body diameter: 1ft 9in (0.533m)
Launch weight: approx 4,085lb (1,853kg)
Range: 23-35 miles (40-56km)

Development and Service

Subroc is one of the most unusual missiles in service. Fired from the standard torpedo tube of a submerged submarine, it is designed to propel itself to the surface, then follow a ballistic trajectory to the predicted position of an enemy submarine, which it attacks with a nuclear depth bomb warhead. To make this possible, the large booster exhausts through thrust vectoring nozzles which enable the missile to change course underwater as well as in flight. The motor does not ignite until the missile has travelled a safe distance from its launch submarine, which need not be pointing towards the target. The Subroc is propelled upward and out of the water. Its inertial guidance system then directs it towards the enemy craft, whose position, course and speed have been computed and fed into the missile guidance before launch. At a pre-determined range, the booster is separated by thrust reversal and an explosive bolt disconnect system. The depth bomb continues in the ballistic trajectory, steered by its tail-fins in accordance with instructions from the inertial guidance system. This determines the position and angle of the missile as it re-enters the water. A special mitigating device cushions the shock of water entry at supersonic speed; the depth bomb then sinks and explodes.

Subroc became operational in 1965, after a highly successful series of full-range tests in the Pacific from the USS *Plunger*. It continues to arm high-speed nuclear attack submarines of the US Navy in world-wide service. An improvement programme to maintain the effectiveness of Subroc was initiated in 1976.



Above: Loading a Subroc missile into a submarine.

Super 530

France

Air-to-air missile. In production and service.

Prime contractor: SA Matra
Powered by: Thomson/Brandt butalane-propellant rocket motor
Airframe: Cylindrical body with pointed ogival nose. Cruciform long-chord, narrow-span wings, indexed in line with cruciform tail-surfaces
Guidance and Control: Dassault (EMD) Super AD-26 semi-active radar homing head
Warhead: Thomson/Brandt warhead, with proximity fuse
Length overall: 11ft 7.25in (3.54m)
Body diameter: 10.25in (0.26m)

Top: Super 530s under the wings of an F1.

Above: Super 530 launch from an F1.

Wing span: 2ft 1.25in (0.64m)
Fin span: 2ft 11.5in (0.90m)
Launch weight: 500lb (226kg)
Max speed: approx Mach 4.5
Range: approx 18.5-21.75 miles (30-35km)

Development and Service

This new missile arms Dassault Mirage F1 interceptors of the French Air Force and will eventually equip the Delta 2000. It is an all-weather and all-sector missile, with the capability of destroying targets flying in excess of 70,000ft (21,335m) and at high speed.

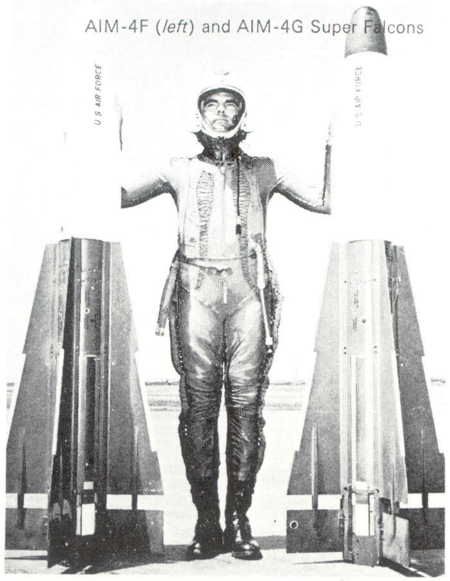
The first ramp-launched test of the Super 530 was conducted in January 1971. The first controlled model was fired successfully in February 1973, and five complete missiles had been launched successfully against airborne targets by early 1975. The first firing from a Mirage F1 was made successfully in January 1976. The evaluation phase by the French Air Force is underway and Matra obtained good results during its last evaluation firings in 1978. Series production began in January 1979.

Super Falcon (AIM-4F/G)

USA

Air-to-air missile. In service.

Prime contractor: Hughes Aircraft Company
Powered by: Thiokol M46 two-stage solid-propellant motor, with first-stage rating of 6,000lb (2,720kg) st
Airframe: Cylindrical body, with cruciform long-chord delta wings, each extended at leading-edge root to form a narrow strake along the fore-part of the body. Cruciform tail control surfaces aft of wings. AIM-4F has ogival nose with central probe; AIM-4G has tapered nose with hemispherical glass tip
Guidance and Control: AIM-4F utilises Hughes semi-active radar homing guidance; AIM-4G uses infra-red homing system. Control by tail surfaces.
Warhead: High-explosive, weighing 40lb (18kg)
Length: AIM-4F 7ft 2in (2.18m)
AIM-4G 6ft 9in (2.06m)
Body diameter: 6.6in (0.17m)
Wing span: 2ft 0in (0.61m)
Launch weight: AIM-4F 150lb (68kg)
AIM-4G 145lb (65.7kg)
Max speed: Mach 2.5
Max range: 7 miles (11km)

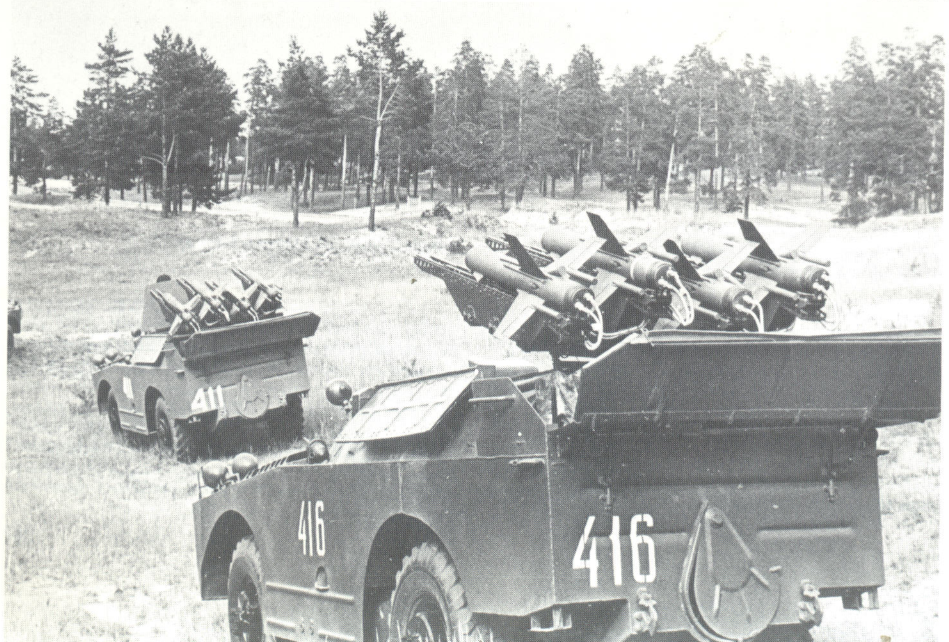


Above: AIM-4F (left) and AIM-4G Super Falcons.

Development and Service
Super Falcon was developed as an interim stage between the AIM-4A/C Falcon and the AIM-26 Falcon (see second edition *Missiles of the World*). First version, introduced in 1958, was the radar-homing AIM-4E (originally GAR-3), which was succeeded in 1960 by the improved AIM-4F (GAR-3A) after only 300 Es had been built. Simultaneously, Hughes introduced the AIM-4G (GAR-4A), with infra-red homing head, and a mixed armament of four AIM-4F/Gs has since been standard in the internal weapons bay of USAF Convair F-106 Delta Dart interceptors. As well as having a higher performance than early Falcons, they are less susceptible to enemy countermeasures.

Swatter (AT-2)

USSR



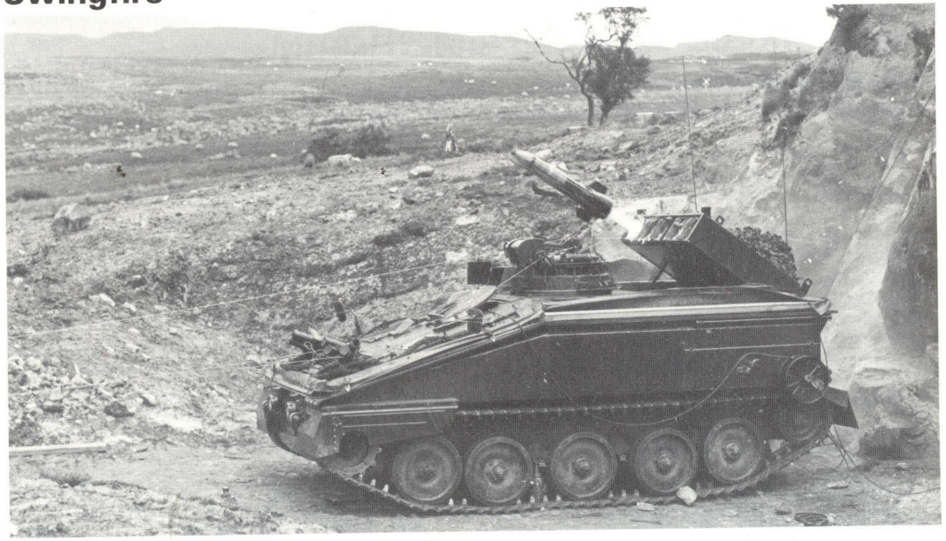
Anti-tank missile. In service.

Powered by: Solid-propellant motor
Airframe: Cylindrical body with blunt rounded nose. Cruciform wings at rear, each with trailing-edge elevon. Tracking flare inboard of elevon on two wings. Two small movable foreplanes. Two motor nozzles on opposite sides of body between wings
Guidance and Control: Command guidance, possibly with infra-red terminal homing. Control via elevons, possibly supplemented by foreplanes during terminal homing
Warhead: Hollow charge
Length: 2ft 11.5in (0.90m)
Body diameter: 5.9in (0.15m)
Wing span: 2ft 2in (0.66m)
Launch weight: 55lb (25kg)
Cruising speed: 335 mph (540km/h)
Range: 985-7,220ft (300-2,200m)

Development and Service
This second-generation missile was first observed on a quadruple, retractable launcher carried by a BRDM vehicle, some years after 'Snapper' entered service. 'Swatter' is a more advanced weapon, and does not utilise wire guidance. This has facilitated its air-to-surface deployment on the twin launchers carried at the tips of the stub-wings of the Mil Mi-24 (NATO 'Hind-A and D') assault helicopter and probably on the Kamov Ka-25 (NATO 'Hormone'). However, this is thought to be an interim measure, until the AS-8 becomes available in sufficient numbers. In its surface-to-surface form, 'Swatter' is in service with the Warsaw Pact countries (except Bulgaria) and Egypt.

Swingfire

UK



Long-range anti-tank missile. In production and service.

Above: Swingfire launch from a Striker reconnaissance combat vehicle.

Data: Basic Swingfire
Prime contractor: British Aerospace Dynamics Group
Powered by: Solid-propellant rocket motor
Airframe: Cylindrical body, with ogival nose and spring-loaded cruciform wings which fold against the rear of the body while the missile is in its launcher
Guidance and Control: Wire-guidance by command signals transmitted by operator via joystick controller. Control by gimballed motor nozzle, known as a jetavator
Warhead: Hollow-charge high-explosive warhead, capable of destroying any known tank
Length: 3ft 8in (1.17m)
Body diameter: 6.7in (0.17m)
Wing span: 1ft 3.75in (0.40m)
Weight: 60lb (27kg)
Range: 500-13,125ft (150-4,000m)

Development and Service
Before the weapon activities of Fairey Engineering Ltd were transferred to British Aircraft Corporation (AT) Ltd, Fairey was working on a long-range command-guided anti-tank weapon known as Orange William. Features of this missile were incorporated in Swingfire, of which development

began in the early 1960s to replace the Malkara in British Army service. Its name reflects the fact that it has a firing arc of 90 degrees from a fixed launcher, enabling it to be launched around corners from a concealed vehicle. When mounted on a traversing turret, targets can be engaged through a full 360-degree field of fire.

The rocket motor is designed to impart a relatively low launch acceleration, making Swingfire sufficiently manoeuvrable to engage targets over a direct-fire range of under 500ft (150m). It is launched from its sealed disposable storage container, which can be mounted on a variety of vehicles, such as the FV 438 armoured personnel carrier, which carries two missiles ready to fire and 12 more stowed; the FV 712 Ferret Mk 5 scout car, which carries four ready to fire and four spares; and the British Army's Alvis Striker tracked reconnaissance combat vehicle. Regiments of the Royal Armoured Corps have been operational with Swingfire since 1969. The Belgian Army also uses the missile on its Striker vehicles. The Egyptian Army operates the missile from Land Rovers carrying four-round pallets, and a production line is being established in Egypt under the terms of a licensing contract covering progressively increasing local assembly until 1985.

A new sighting and guidance station incorporating the electronics necessary for the launching and guidance of Swingfire missiles has now been developed. This enables Swingfire to be mounted on to any highly mobile lightweight vehicle, such as a Saboteur. This system is the light air transportable Swingfire which can be slung under a helicopter and dropped into the battlefield by parachute. Infantry transportable Swingfire comprises the new sighting and guidance station and a lightweight two-wheeled trolley which carries the missile and acts as the launcher. One man can move, deploy and operate the complete system.

Talos (RIM-8G-AAW and RIM-8H-ARM)

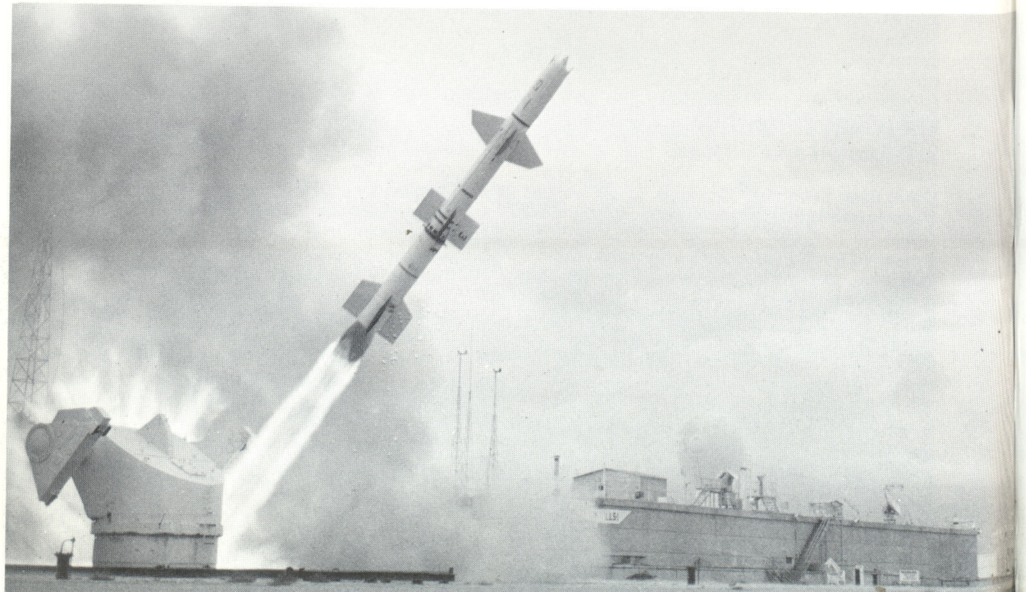
USA

Ship-launched surface-to-air and surface-to-surface missile. In service.

Prime contractor: The Bendix Corporation, Guidance Systems Division. Mishawaka Operation
Powered by: 40,000 hp Bendix 28in (710mm) ramjet sustainer and Allegany Ballistics tandem jettisonable solid-propellant booster
Airframe: Tandem two-stage missile. Cylindrical missile body, tapering toward nose air-intake which contains conical centre-body. Pivoted cruciform wings mid-way back on body and indexed in line with rectangular cruciform tail-fins. Cylindrical booster with four tail-fins indexed in line with fins of missile
Guidance and Control: Beam-riding, with terminal semi-active radar homing. Control by pivoted wings
Warhead: Alternative nuclear or high-explosive, with proximity fuse
Length: 31ft 3.25in (9.53m) with booster
21ft 0in (6.40m) without booster
Body diameter: 2ft 6in (0.76m)
Wing span: 9ft 6in (2.90m)
Launch weight: 7,000lb (3,175kg)
Max speed: Mach 2.5
Max range: 70 miles (112km)

Development and Service
The effectiveness of this big ramjet-powered missile was demonstrated in 1968, when Talos missiles launched from the nuclear-powered cruiser *Long Beach* destroyed two MiG fighters flying over North Vietnam, some 70 miles (112km) from the ship. Other US Navy cruisers continue to deploy Talos, and the designation RIM-8H-ARM given to one current version shows that it carries an anti-radiation homing head for surface-to-surface use against enemy radars at sea or on land.

Talos, like Terrier, was one of the first US surface-to-air missiles, tracing its development back to the Bumblebee research programme which the Applied Physics Laboratory of Johns Hopkins University initiated in 1944. It was first fired at sea, from the USS *Galveston*, on 24 February 1959. Operational deployment of Talos is expected to continue into the early 1980s, probably to be replaced then by the Aegis missile system with extended-range missiles.



TAN-SAM

Japan

Surface-to-air missile. Under development?

Prime contractor: Tokyo Shibaura Electric Company
Powered by: Nissan solid-propellant rocket motor
Guidance and Control: Infra-red homing guidance system
Length: 8ft 10in (2.70m)
Body diameter: 7in (0.18m)
Launch weight: 220lb (100kg)
Max speed: Mach 2

Development and Service
It has been reported that Tokyo Shibaura has developed a small air defence missile for the Japanese Army, intended to fill the defence gap between anti-aircraft guns and Hawk missiles. It is used in association with phased-array radar for target designation, acquisition and tracking. By 1978, approximately 17 prototype rounds had been launched. The JMSDF is also studying the missile. Production and deployment could possibly be underway.

Tartar (RIM-24)

USA

Ship-based surface-to-air missile. In service.

Prime contractor: General Dynamics Corporation
Powered by: Aerojet-General dual-thrust solid-propellant rocket motor
Airframe: Cylindrical body with ogival nose, cruciform long-chord wings of constant narrow span and cruciform tail control surfaces immediately to rear of wings
Guidance and Control: General Dynamics semi-active radar homing. Control by tail surfaces
Warhead: High-explosive, with impact and proximity fuses
Length: 15ft 0in (4.57m)
Body diameter: 1ft 1.5in (0.34m)
Launch weight: 1,500lb (680kg)
Max speed: above Mach 2
Max range: over 10 miles (16km)

Development and Service
In general appearance Tartar resembles the second stage of the Advanced Terrier missile. It was developed by the Bureau of Naval Weapons, and produced by Convair Pomona, to provide a compact primary anti-aircraft defence for US Navy guided missile destroyers and guided missile frigates and secondary defence for guided missile cruisers. Full production began in 1960 and was completed in 1968, by which time Tartar equipped many US Navy ships, three Perth class Australian, four French Type 47 (now with Standard Missile), three West German Lùtjens class, one Japanese Amatsukaze class and two Italian Impavido class (now with Standard Missile) destroyers. By 1979 about 33 US ships carried Tartar launchers and missiles. Tartar is being replaced by RIM-66 medium-range Standard Missile, which it resembles in appearance, and many other US ships deploy Tartar launchers and these newer missiles. Similar Tartar/Standard weapon systems are carried by other ships of Italy, Iran, Japan, the Netherlands and Spain.

Below: Tarter leaving the guided missile destroyer USS *Sampson.*

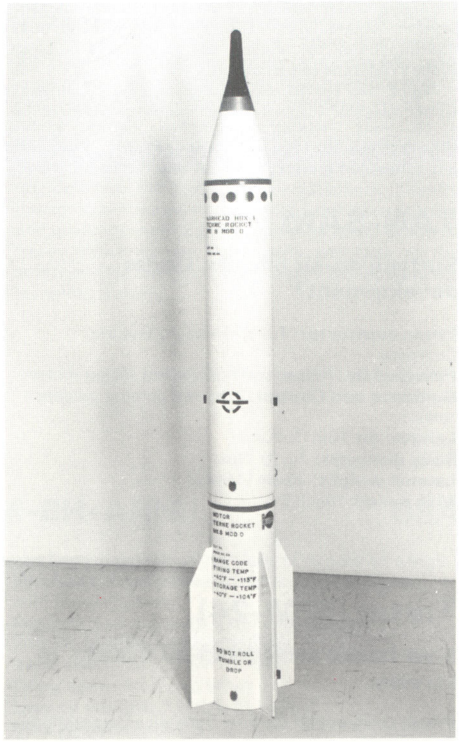
Terne Mk 8

Norway

Anti-submarine rocket depth-charge. In service.

Prime contractor: A/S Kongsberg Vaapenfabrikk
Powered by: Two concentric solid-propellant rocket motors
Airframe: Cylindrical body with cruciform tail-fins. Ogival nose-cone, tapering to slim cylindrical tip
Guidance and Control: Sonar on ship determines range, bearing and depth of target before Terne is fired. No in-flight guidance
Warhead: High-explosive, weighing 110lb (50kg), with combined acoustic proximity, impact and time fuse
Length: 6ft 4.75in (1.95m)
Body diameter: 8in (0.203m)
Launch weight: 298lb (135kg)
Performance : approx 1.9 miles (3km)

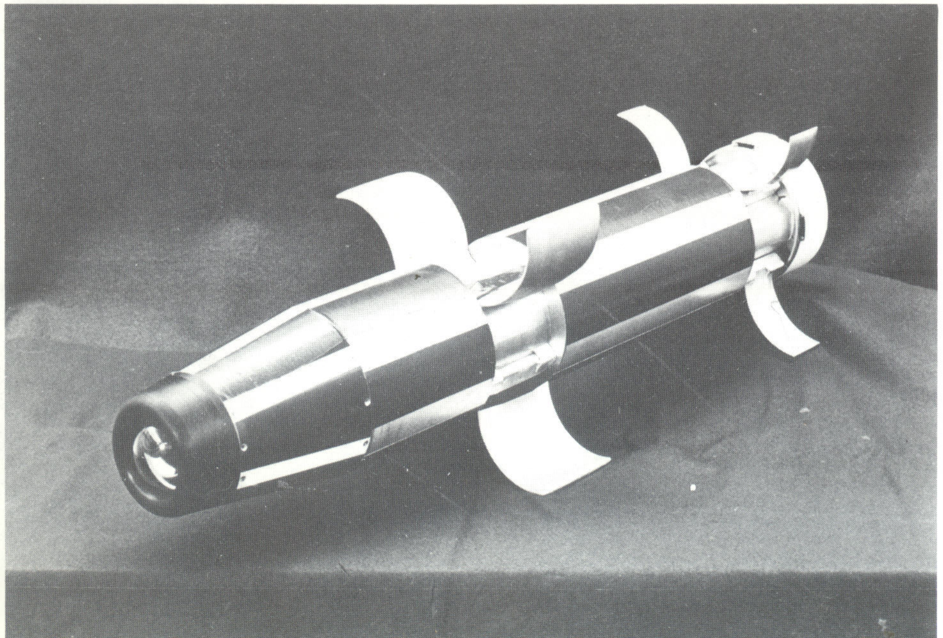
Development and Service
Operational on ships of the Royal Norwegian Navy, this rocket-propelled depth charge system can be installed on ships of any size down to small escort vessels. Once the ship's sonar has established the position of the enemy submarine, a full salvo of six Ternes can be fired in five seconds. The improved rocket motors of Terne Mk 8 give it about twice the range of the earlier Mk 7 version.



Right: Terne Mk 8.

TGSM

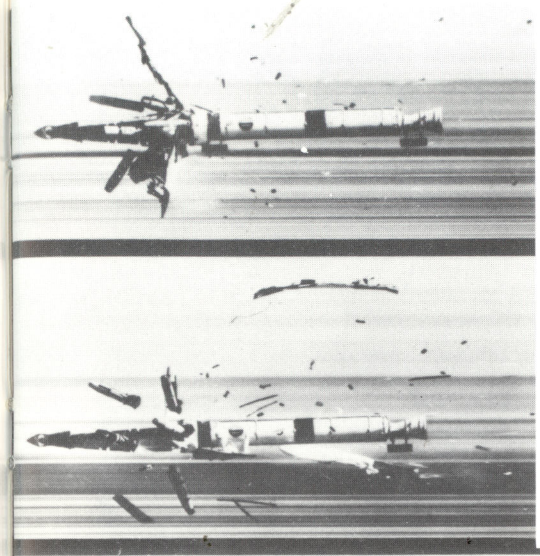
USA

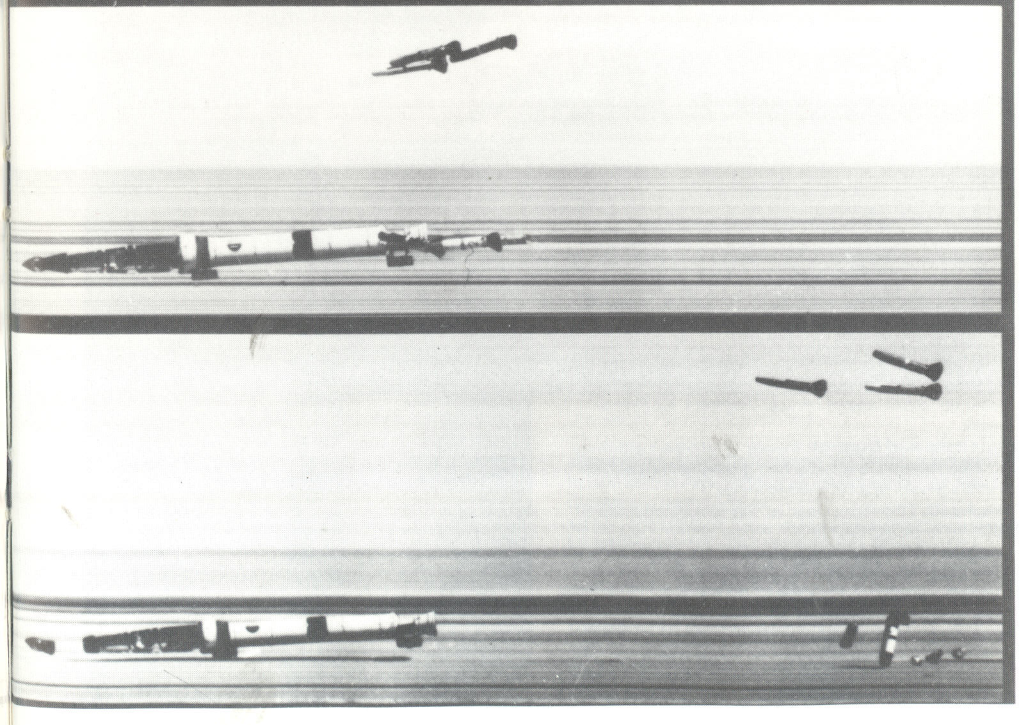


Anti-tank missile system. Exploratory development.

Prime contractor: Vought Corporation, Michigan Division
Powered by: No propulsion in submissiles
Airframe: Cylindrical body, tapering towards nose. Cruciform wrap-around wings and movable tail surfaces
Guidance and Control: Each submissile has terminal homing and seeker. Control via tail surfaces
Warhead: Armour penetration
Length: 2ft 11in (0.89m)
Body diameter: 6in (0.15m)
Weight: 35lb (15.9kg)

Development and Service
The Terminally-Guided SubMissile (TGSM) is a concept being investigated to achieve an effective indirect fire capability for destroying tanks. A dispensing rocket or missile is launched with a warhead containing the submissiles. An explosive charge breaks open the warhead skin and the airflow provides sufficient force to catapult the submissiles away from the delivery vehicle and disperse them over the target area. Each submissile has a balloon parachute system to decelerate, stabilise and orient it. Four tail-fins then open out and the balloon parachute is ejected. Each submissile has a guidance system and seeker which searches for a target. When a target is found, the submissile uses its movable tail surfaces to guide itself to target impact. Once launched, the missile system is independant of ground control. Components of TGSM have been tested on a subsystem basis.





Left & below: TGSM high-speed test to evaluate dispensing system.

Tigercat

UK

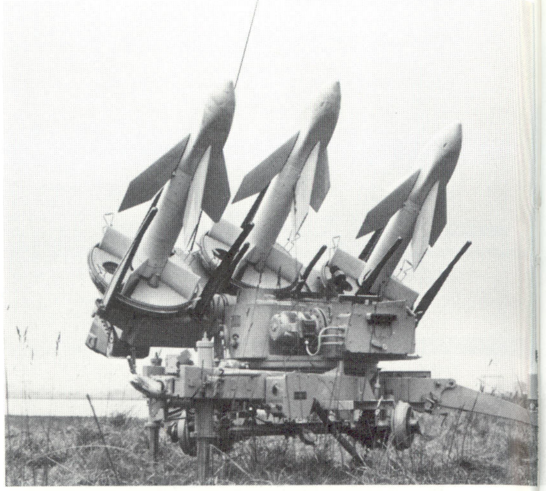
Close-range surface-to-air missile system. In production and service.

Prime contractor: Short Brothers Ltd
Powered by: Two-stage solid-propellant rocket motor
Guidance and Control: Radio command with optical tracking. Radar tracking system for dark fire capability. Control via movable wings
Warhead: High-explosive with proximity fuse
Length: 4ft 10.25in (1.48m)
Body diameter: 7.5in (0.19m)
Launch weight: 132lb (60kg)
Range: over 15,580ft (4,750m)

Development and Service

This missile system was evolved specifically as an unsophisticated guided weapon with instant readiness for the point defence of airfields and other important potential target areas on land. The Tigercat missile is identical with Seacat (qv), which speeded development of the system, and it has been operational with the RAF Regiment since 1970. Other users include the Air Force of Iran, the Armies of Argentina, Jordan and Qatar, the Argentinian Marine Corps and India.

In its mobile form, Tigercat comprises a three-round launcher-trailer and a director trailer, housing the optical sighting and launch control equipment. They can be towed by two vehicles such as Land-Rovers, carrying the launch crew, additional missiles, generator and other items. In operation, after the target has been acquired by the aimer and the missile fired, the aimer uses a thumb-operated controller to guide the missile along the line-of-sight to the target. By integrating Tigercat with a fire control radar such as the Marconi 850 or HSA Flycatcher both dark and blind fire can be added to the optical line-of-sight mode of operation.

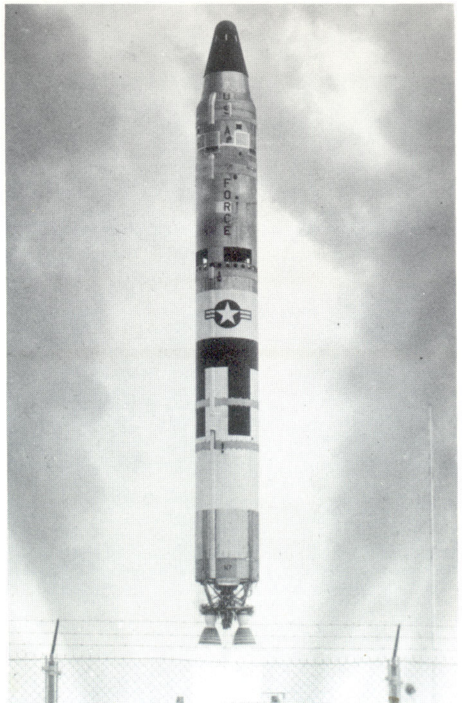


Titan II (LGM-25C)

USA

Intercontinental ballistic missile. In service.

Prime contractor: Martin Marietta Corporation
Powered by: First stage Aerojet-General LR87-AJ-5 storable liquid-propellant engine rated at 430,000lb (195,000kg) thrust
Second stage Aerojet-General LR91-AJ-5 storable liquid-propellant engine rated at 100,000lb (45,360kg) thrust
Airframe: Two-stage missile. Cylindrical body of high-strength aluminium alloy, with constant diameter. Blunt-nosed conical warhead. No fins or wings
Guidance and Control: Inertial guidance system by AC Electronics. Control by two gimballed nozzles on first stage and one on second stage
Warhead: Thermonuclear, in General Electric Mk 6 ablative re-entry vehicle
Length: 102ft 8.25in (31.30m)
Max body diameter: 10ft 0in (3.05m)
Launch weight: 330,000lb (149,690kg)
Max speed: 17,000mph (27,360km/h)
Max range: 9,320 miles (15,000km)



Right: Titan II launch.

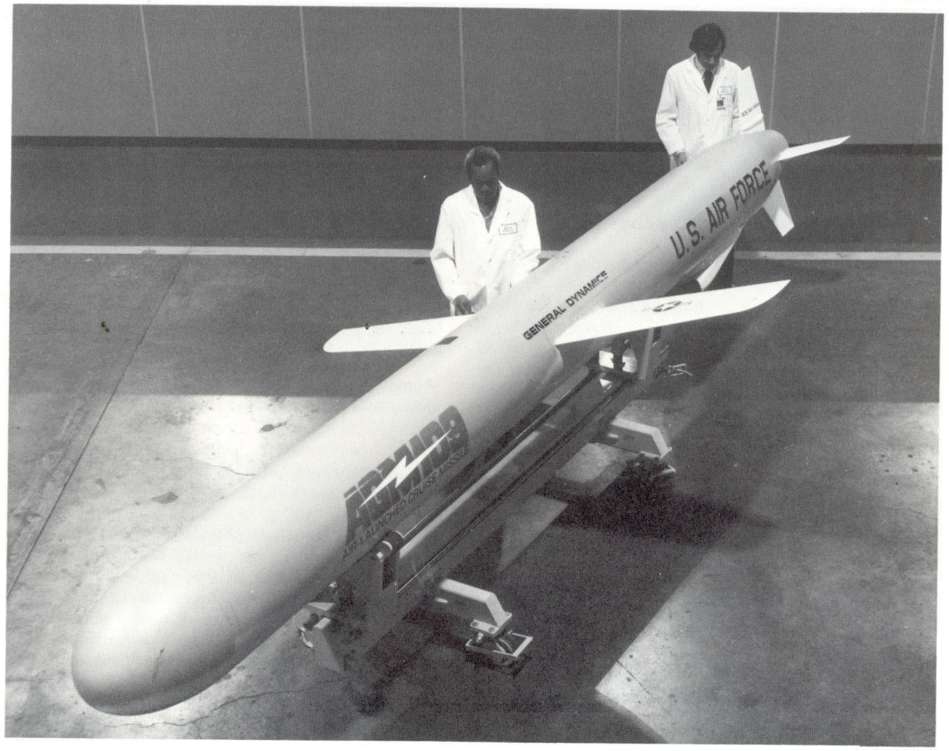
Development and Service

The USAF's Strategic Air Command deployed originally two huge liquid-propellant ICBMs, named Atlas and Titan. Titan I became operational in 1962 and was joined by Titan II in the following year. This was by far the most formidable of all America's first-generation long-range missiles. It could be stored in, and launched from, an underground silo, and carried the largest H-bomb warhead that has ever been fitted to a US missile. As a result, the USAF decided to retain six squadrons of Titan IIs, with a total of 54 missiles, although its original intention had been to withdraw all liquid-propellant ICBMs from service as the Minuteman force became operational.

The Titan IIs are based at Davis-Monthan AFB, Arizona, McConnell AFB, Kansas, and Little Rock AFB, Arkansas. The re-entry vehicle carried by each missile is so designed that its speed and trajectory are corrected by four small vernier rockets before it separates from the burned-out second stage. It carries advanced penetration aids to make detection and destruction by an ABM extremely difficult.

Tomahawk (AGM-109/BGM-109)

USA



Above: AGM-109 Tomahawk.

Cruise missile. Under development.

Contractor: Convair Division of General Dynamics
Powered by: Williams Research Corporation F107-WR-400 turbofan engine, in 600lb (272kg) thrust class. Surface and submarine launched missiles have an Atlantic Research Corporation solid-propellant motor, in 7,000lb (3,175kg) thrust class, in tandem for boost and underwater steering
Airframe: Cylindrical torpedo-shape body made of aluminium, tapering at tail. Two narrow-chord wings approximately midway between nose and tail, which fold inside body when the missile is in its launch capsule and extend forward for cruising flight in the atmosphere. Cruciform folding tail surfaces indexed in line with wings. Ventral air intake for cruise engine
Guidance and Control: Inertial guidance, with terrain comparison (map-matching) system supplied by McDonnell Douglas Astronautics Company for land attack version. Modified Harpoon missile guidance for anti-ship version
Warhead: Nuclear or conventional
Length: 21ft (6.40m) with booster
18ft 3in (5.56m) without booster
Body diameter: 1ft 9in (0.53m)
Wing span: 8ft 4in (2.54m)

Launch weight: approx 2,550lb (1,157kg)
Cruising speed: approx 550mph (885km/h)
Range: Land-attack over 1,555 miles (2,503km)
Anti-ship over 280 miles (451km)

Development and Service

Known originally as the submarine-launched cruise missile (SLCM), Tomahawk is now being developed in both land attack and anti-ship forms, for launching from aircraft and surface installations as well as from submerged submarines. The US Navy BGM-109 version, as described in detail below, was the original version of Tomahawk, and in October 1978 made 35 flights comprising seven underwater launches, two surface launches and 26 air launches. From the BGM-109 were developed the AGM-109 air-launched cruise missile for the USAF's Strategic Air Command, developed to compete with Boeing's AGM-86B to arm B-52s, and Tactical Air Command's ground-launched cruise missile (GLCM), designed to increase its strike capability and give TAC improved nuclear and conventional armament. The land attack weapon is turbofan-powered, with a solid-propellant tandem rocket boost and nuclear warhead. Conversion to anti-ship role involves substitution of tactical guidance and a conventional warhead. Fuel tankage is much reduced in this variant. No booster is fitted to either type of weapon when it is to be air-launched.

Initial development contracts for the naval weapon were awarded to LTV and GD in January 1974. Main difference in approach by the competing companies was that LTV used a strong stainless steel airframe for its BGM-110, while GD designed its BGM-109 to be tube-launched from a high-strength steel capsule in underwater and surface roles. This enables the missile itself to be built for maximum flight performance instead of being penalised by the extra weight that is otherwise needed to survive underwater launch and handling. The BGM-109, in its capsule, is loaded into the submarine's torpedo tube for firing. The tube is then flooded and the missile (held dry in the capsule until the moment of firing) is pressurised. Using the submarine's fire control system, the missile is checked out and the guidance is aligned. Ejection from the torpedo tube, by the submarine's normal hydraulic system, leaves the missile's steel capsule momentarily inside the tube. A lanyard attached to the capsule is pulled as the missile clears the submarine, resulting in booster ignition; the empty capsule is then ejected from the ship. Underwater boost and steering for the missile are provided by the solid-propellant motor, with jet tab control. During this phase, the pressure within the missile 'breathes out' in scuba-dive fashion. When the missile breaks the surface of the water, its aerodynamic surfaces and turbofan inlet are deployed automatically and it transitions to cruising flight on the power of the turbofan. Tomahawk then flies to the target at high subsonic speed, at very low altitude, guided by the US Navy's TERCOM terrain comparison method, in which the missile's computer compares the terrain over which it travels with its preprogrammed path, recorded on a digital map.

Above: BGM-109 Tomahawk emerging from the sea under boost motor power.

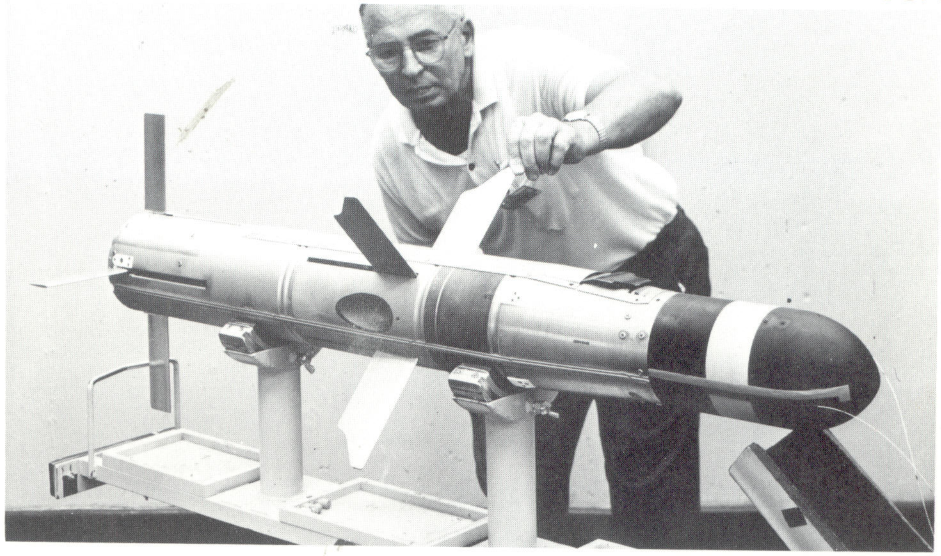
Wind tunnel tests, vibration tests and checkout of the underwater launch and boost sequence, as well as tests of flight vehicles, continued during 1975, using YBGM-109/110 development vehicles. On 13 February 1976, a YBGM-109 was first to demonstrate successfully an underwater launch and boost-to-glide sequence. On 17 March the US Navy announced its choice of this missile for continued development. The first air launch and test flight of a complete anti-ship Tomahawk took place in March 1976, and in June the first air launch and test flight of a fully-guided land attack missile was achieved. In February 1977 the first boost-to-cruise demonstration missile was launched from a truck, and in April an over-the-horizon anti-ship search mission was successfully flown. In June of the same year a Tomahawk anti-ship missile was launched successfully from an underwater torpedo tube to demonstrate boost flight and transition to turbofan engine flight and in February 1978 two land attack and anti-ship Tomahawks were fired from USS *Barb*, an operational nuclear attack submarine.

Requirements of the Tomahawk programme include low radar cross-section, minimum visual and infra-red signatures and ability to operate on heavy hydrocarbon fuel.

A series of 10 flight tests with the AGM-109 began in 1979. Similarly, testing of the GLCM was scheduled to begin in 1979, with early operational capability two years later.

TOW (BGM-71A)

USA



Heavy anti-tank missile. In production and service.

Prime contractor: Hughes Aircraft Company
Powered by: Hercules Inc K-41 solid-propellant motor, with two separate boost periods
Airframe: Cylindrical body, tapering to a rounded nose section of smaller diameter. Cruciform wings, mid-way back on body, are folded inside launch-tube and flick forward as missile leaves launcher. Cruciform narrow-chord tail control surfaces, indexed at 45 degrees to wings, flick open rearward at launch
Guidance and Control: Wire guidance. Automatic missile tracking and command via optical sight. Control by tail surfaces
Warhead: High-explosive shaped charge, weighing 8lb (3.6kg)
Length: 3ft 9.75in (1.18m)
Max body diameter: 5.9in (0.15m)
Wing span: 1ft 1.5in (0.34m)
Launch weight: 42lb (19kg)
Max speed: High subsonic
Range limits: 215-12,300ft (65-3,750m)

Development and Service

The TOW (Tube-launched Optically-tracked Wire guided) anti-tank weapon system was conceived for the US Army as a replacement for the 106mm recoilless rifle and Entac and SS.11 missiles. It consists of a glassfibre launch-tube, a tripod mounting, a traversing and sighting unit, an electronic package and the TOW missile in a shipping/launch container which forms an extension of the launch-tube. Weight of the complete system is about 175lb (79.4kg), but it can be broken down into four units for carriage by infantry. It can be mounted on wheeled or tracked vehicles, and the US Army operates it on armoured personnel carriers and jeeps.

Above: TOW fired from a US Army lightweight Fighting Vehicle System (FVS).

The missile itself is never handled by the launch-crew, all electrical and mechanical connections being made automatically when its container is inserted in the launch-tube. The solid-propellant motor burns initially only long enough to propel TOW from the

Above: Agusta 109 helicopter carrying TOW missiles.

launcher. To ensure safety for the operator, the missile then coasts for a time before the second stage fires, well clear of the mouth of the launch-tube. To guide it to the target, the operator has only to keep the target centred in a telescopic sight.

Firing trials began in 1965, and production in November 1968. Deployment to US Army units in the USA and Europe was started in November 1970, and the missile's effectiveness was demonstrated in Vietnam in 1972. An infra-red sight has been developed to permit use of TOW at night. TOW was also used very successfully in an air-to-surface role in Vietnam in 1972, from some of the eight Bell AH-1G HueyCobra helicopters modified under the Improved Cobra Armament Program. Because of the temperatures and altitudes encountered in that war zone, the aircraft proved able to carry only two to six TOWs, with a gyro-stabilised sight, instead of the full planned complement of eight TOWs. However, a further 290 AH-1Gs are being modified to similar AH-1Q TOW/Cobra standard for the US Army, and delivery of these began in June 1975. Orders for over 275,000 TOW missiles have been placed by the US Army, US Marine Corps and the armed services of other countries. Of these more than 223,000 have been delivered. All TOW missiles delivered since mid-1976 have a range of 12,300ft (3,750m).

Trident

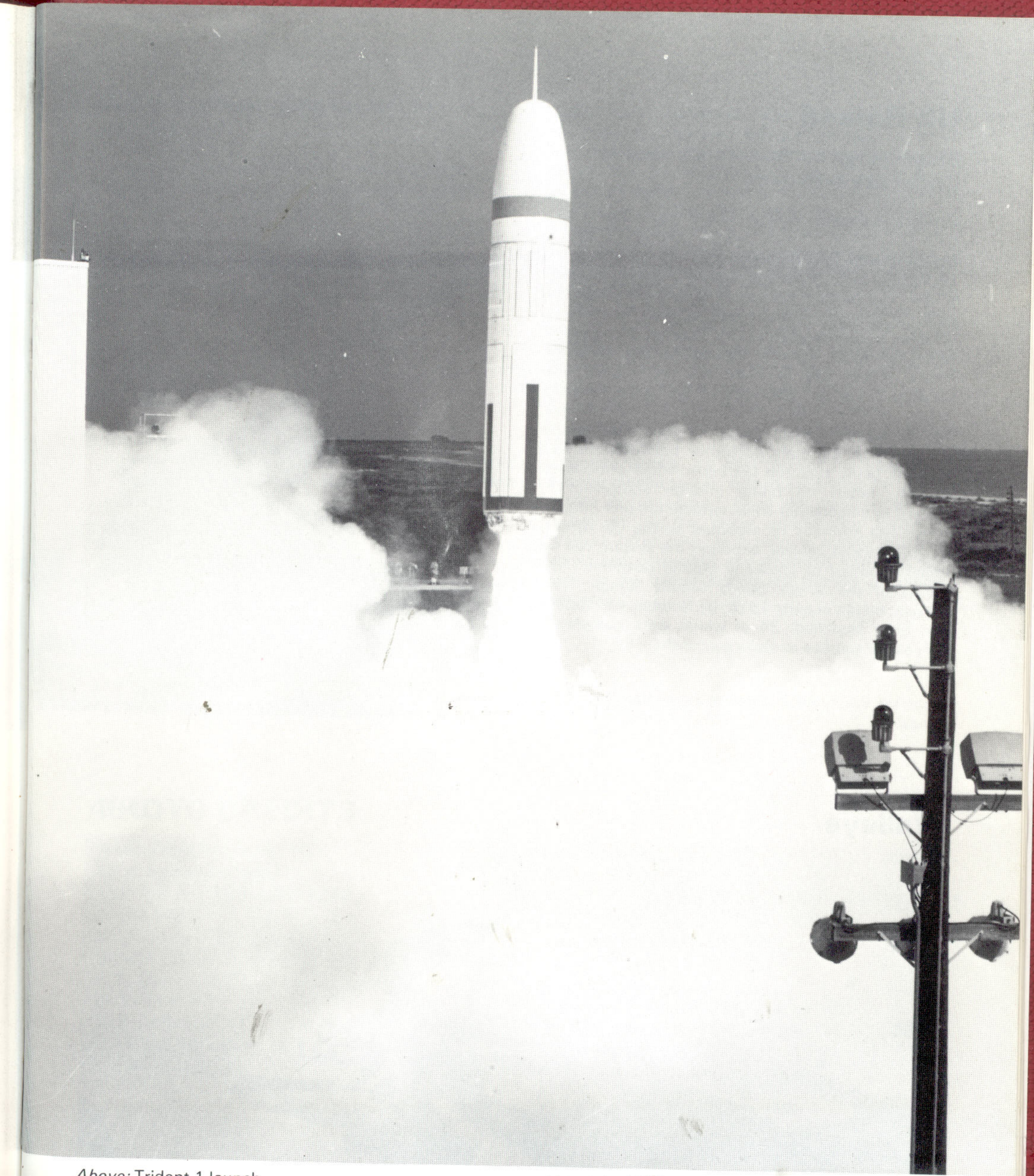
USA

Underwater-to-surface ballistic missile. In production and service.

Prime contractor: Lockheed Missiles and Space Company
Powered by: Hercules/Thiokol solid-propellant motors
Airframe: Three-stage missile. Cylindrical body with ogival nose-cone. Retractable Aerospike in nose. No fins or wings
Guidance and Control: Inertial guidance
Warhead: Thermonuclear, in multiple independently targetable re-entry vehicles
Length: 34ft 0in (10.36m)
Body diameter: 6ft 2in (1.88m)
Launch weight: 65,000lb (29,480kg)
Max range: 4,600 miles (7,400km)

Development and Service

The Trident 1 (C4), formerly called ULMS (Undersea Long-range Missile System), has been under development for some years as a third-generation follow-on to Polaris and Poseidon. The missile's range will make the carrier-submarines much more difficult to locate and track, by extending immensely the area of ocean in which they can patrol and still be within range of their designated targets. Trident missiles can be launched from a submerged or surfaced submarine. The missile is being installed in 10 of the present Poseidon submarines and will be installed in the new 24-tube Trident submarines, the latter of which will have better command and control systems and sonar than previous fleet ballistic missile (FBM) submarines. Altogether, 13 Ohio class Trident submarines will be built.



Above: Trident 1 launch.

Development of the Trident 1 (C4) was awarded to Lockheed in 1974. The first missile launch was made from Cape Canaveral on 18 January 1977, and by early 1978 12 flight tests had taken place, all but one successfully. Operational deployment of the Trident 1 in the modified Poseidon submarines was expected to begin in late 1979. Deployment of Trident 1 missiles in Ohio submarines is not expected until 1981 at the earliest.

Development is continuing on a Trident II missile of much improved accuracy and greater warload, which could be operational in the latter 1980s, and on the Mk 500 Evader manoeuvring re-entry vehicle (MARV) to elude advanced Soviet ABMs.

US Roland

USA

Close-range surface-to-air missile. Under development.

Prime contractor: Hughes Aircraft Company

Development and Service

US Roland is an American licence-produced version of the Euromissile Roland. It is a close-range air defence system which can protect stationary vehicles or emplacements and moving columns and armoured units against high-speed low level air attack during day or night and in virtually any weather condition. The missiles and approximately 90% of the field replaceable parts are interchangeable with those of the Euromissile counterparts, the main difference between the two systems being that the US version has a modified tracking radar. All prime mission equipment is housed in a helicopter-transportable fire unit module which will normally be mounted on the US Army's M-109 tracked vehicle, although the system can be trailer-mounted or placed in ground positions. Test firings at the White Sands Missile Range, New Mexico, began in early 1978; by October 45 missiles had been launched, 34 of which were completely successful and five partially successful.

Right: US Roland test launch at White Sands Missile Range.

Walleye

USA

387
CAUTION

Air-to-surface 'glide bomb'. In service.

Data: Walleye 1
Prime contractor: Martin Marietta Corporation
Airframe: Cylindrical body, with tapering tail-cone and glass-tipped ogival nose. Rear-mounted cropped-delta cruciform wings, each with trailing-edge control surface
Guidance and Control: Self-homing TV guidance system. Control by aerodynamic surfaces on wings
Warhead: High-explosive, Mk 1 Mod 0.850lb (385kg)
Length: 11ft 3in (3.44m)
Body diameter: 1ft 3in (0.38m)
Wing span: 3ft 9in (1.14m)
Launch weight: 1,100lb (500kg)

Development and Service

Although Walleye is unpowered, it was once described by the US Navy as the most accurate and effective air-to-surface conventional weapon ever developed anywhere. The Naval Weapons Center at China Lake, California, was responsible for its development, the idea being to produce a 'smart bomb' that would find its own way unerringly to the target after the launch aircraft had turned for home. Martin Marietta received their first production contract in January 1966, their assembly lines being supplemented by others at Hughes Aircraft Company for a period, to meet the demands of the war in Vietnam. Development of a Walleye 2 version by Martin Marietta began in the spring of 1971. This version has a warhead in the 2,000lb (907kg) range and is some 2ft (60cm) longer than the original version. It is also in service. The latest version is Extended-Range, Data Link Walleye II, which has larger wings and data link equipment. Walleye Is and IIs are being modified to the latest standard.

Walleye is carried by a variety of aircraft including the A-4, A-6, A-7 and F-4.

Before launch, the pilot focuses the missile's TV camera on the target, with the aid of a TV monitor screen in the cockpit. Once the camera has been locked on to the target, mechanism inside the Walleye takes over, 'watching' a screen inside the bomb and correcting any deviation from the flight path to the target during the bomb's unpowered descent.

Below left: Walleye on an A-4 Skyhawk.

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R. S. Olive 63
S. R. Peltz 20(TL)
Ing Hans Redeman 12
B.M. Service 52(B), 118
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Tass 7(T), 18(T), 35(B), 37, 40(T), 43(TL&R), 45, 46(T), 94(B), 95, 96, 99(T), 100(T), 102, 109, 115(T), 136(B)
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US Navy 5(T), 17(R), 21, 46(B), 107(T), 113, 114, 131(T), 133(B), 139, 148(B)

INDEX

AA-1 Alkali 7
AA-2 Atoll 18
AA-3 Anab 7-8
AA-5 Ash 15
AA-6 Acrid 3
AA-7 Apex 8
AA-8 Aphid 8
AAM-1 3
AAM-2 3
ABM-1B Galosh 38
Acrid (AA-6) 3
ADM-20C Quail 84
Advanced Atoll 18
Advanced Terrier (RIM-2F) 4
Aegis 4
AGM-12B/E Bullpup A 21
AGM-12C/D Bullpup B 21
AGM-22A (AS.11) 9
AGM-45A Shrike 113
AGM-65 Maverick 67-68
AGM-69A SRAM 120-121
AGM-78 Standard ARM
  129-130
AGM-84A Harpoon 47-48
AGM-86B ALCM 6
AGM-88A HARM 46
AGM-109 Tomahawk
  143-144
AIM-4D Falcon 32
AIM-4F/G Super Falcon 136
AIM-7 Sparrow 118-119
AIM-9 Sidewinder 113-114
AIM-54A Phoenix 80-81
AIR-2A Genie 42
AJ.168 Martel 65-66
Albatros 5
ALCM (AGM-86B) 6
Alkali (AA-1) 7
Alternate Stinger 132
AM39 Exocet 30-31
AMRAAM 7
Anab (AA-3) 7-8
Apex (AA-7) 8
Aphid (AA-8) 8
Argentine air-to-surface
  missile 8
Argentine anti-tank missile 9
AS-2 Kipper 59
AS-3 Kangaroo 56
AS-4 Kitchen 59
AS-5 Kelt 57
AS-6 Kingfish 58
AS-7 Kerry 58
AS-8 9
AS.11 (AGM-22A) 9
AS.12 10-11
AS.15 11-12
AS.15TT 11-12
AS.20 12
AS.30 12-13
AS.30 Laser 13-14
AS.37/AJ.168 Martel 65-66
ASALM 14
Ash (AA-5) 15
ASM-1 15
ASMP 15
Aspide 16
Asroc (RUR-5A) 16-17
AS-X-9 17
AS-X-10 17
AS-X-11? 17
AT-1 Snapper 117
AT-2 Swatter 136-137
AT-3 Sagger 94-95
AT-5 18
ATM-1 KAM-3D 55
Atoll (AA-2; Soviet
  designation K-13A) 18

Bantam (RB53) 19
BGM-7IA TOW 145-146
BGM-109 Tomahawk 143-144
Bloodhound Mk 2 (Swedish
  Air Force designation
  RB68) 19-20
Blowpipe 20-21
BO810 Cobra 2000 25-26
Bullpup A (AGM-12B/E) 21
Bullpup B (AGM-12C/D) 22

Cactus (Crotale) 27-28
Carcara 22
CF.299 Sea Dart 103-104
Chaparral (MIM-72A) 22-23
Chinese anti-ship missile 24
Chinese ICBMs (CSS-3 and
  CSS-X-4) 24
Chinese IRBM (CSS-2) 24
Chinese MRBM 24-25
Chinese SLBM 25
Chinese surface-to-air
  missile 25
CL834 Sea Skua 105
Cobra 2000 (BO810) 25-26
Copperhead 26-27
Crotale/Cactus 27-28
Cruise Missiles 28
CSS-2 (Chinese IRBM) 24
CSS-3 (Chinese ICBM) 24
CSS-X-4 (Chinese
  ICBM) 24

Dragon (M47) 28-29

Entac (MGM-32A) 29
Exocet (MM38, AM39 and
  MM40) 30-31

Falcon (AIM-4D) 32
Falcon (HM-55/HM-58)
  (Swedish Air Force
  designations RB27 and
  RB28) 32-33
FIM-43A Redeye 91
Firestreak 33-34
FOBS Scarp 100-101
FRAS-1 34
Frog-3, 4 and 5 34
Frog-7 36

Gabriel 36-37
Gainful (SA-6) 37
Galosh (ABM-1B) 38
Gammon (SA-5) 38-39
Ganef (SA-4) 39
GBU-8 (HOBOS) 40-41
GBU-15 40-41
Gaskin (SA-9) 40
Gecko (SA-8) 41
Genie (AIR-2A) 42
Goa (SA-3/SA-N-1) 42-43
Goblet (SA-N-3) 43
Grail (SA-7) 43-44
GSRS 44
Guideline (V750VK) (SA-2/SA-
  N-2) 45
Guild (SA-1) 46

HARM (AGM-88A) 46
Harpoon 47
Harpoon (AGM-84A and RGM-
  84A-1) 47-48
Hawk (MIM-23A) 49
Hellfire 50
HM-55/HM-58 Falcon 32-33
HOBOS (GBU-8) 40-41
Honest John (MGR-1) 50-51
HOT 51-52

Ikara 52-53
Improved Hawk (MIM-23B) 49
Indigo-MEI 53-54

Jericho (MD-660) 68

K-13A Atoll 18
KAM-3D (Type 64 ATM-1) 55
KAM-9 (TAN-SSM) 56
Kangaroo (AS-3) 56
Kelt (AS-5) 57
Kerry (AS-7) 58
Kingfish (AS-6) 58
Kipper (AS-2) 59
Kitchen (AS-4) 59
Kormoran 60

Lance (MGM-52C) 61-62
Lasso 62
LGM-25C Titan II 142-143
LGM-30C Minuteman 69-70
Luz 1 63

M-2 MSBS 71
M-4 MSBS 72
M-20 MSBS 71
M47 Dragon 28-29
Magic (R.550) 85-86
Malafon 63
Mamba 64
Mariner 64
Marte 65
Martel (AS.37/AJ.168) 65-66
Masurca MQ2 66-67
Maverick (AGM-65) 67-68
MD-660 (Jericho) 68
MGM-31A Pershing 79-80
MGM-32A Entac 29
MGM-51A Shillelagh 112
MGM-52C Lance 61-62
MGR-1 Honest John 50-51
MILAN 68-69
MIM-14B Nike Hercules 74
MIM-23A Hawk 49
MiM-23B Improved Hawk 49
MIM-72A Chaparral 22-23
Minuteman (LGM-30) 69-70
MM38/MM40 Exocet 30-31
Mosquito 70-71
MSBS (M-2 and M-20) 71
MSBS (M-4) 72
M-X 73

Naval Crotale 73-74
Nike Hercules 74

Otomat 75
P3T 75-76
Patriot (XMIM-104) 76-77
Paveway 77
Penguin 78-79
Pershing (MGM-31A) 79-80
Phoenix (AIM-54A) 80-81
Pluton 81-82
Polaris (UGM-27) 82-83
Poseidon (UGM-73) 83-84

Quail (ADM-20C) 84

R.530 85
R.550 Magic 85-86
Rapier 86-87
RB04 87-88
RB085A 88-89
RB07 Seacat 102-103
RB08A 89-90
RB27/RB28 Falcon 32-33
RB53 Bantam 19
RB68 Bloodhound Mk 2
  19-20
RB83 90
RBS70 90-91
Redeye (FIM-43A) 91
Red Top 92
RGM-66D Standard ARM
  129-130
RGM-84A-1 Harpoon 47-48
RIM-2F Advanced Terrier 4
RIM-7H Sea Sparrow 106-107
RIM-8G-AAW/RIM-8H-ARM
  Talos 138-139
RIM-24 Tartar 139
RIM-66/RIM-67A Standard
  Missile 130-132
Roland 92-94
RUR-5A Asroc 16-17

S-2 SSBS 125-126
S-3 SSBS 126-127
SA-1 Guild 46
SA-2/SA-N-2 Guideline 45
SA-3/SA-N-1 Goa 42-43
SA-4 Ganef 39
SA-5 Gammon 38-39
SA-6 Gainful 37
SA-7 Grail 43-44
SA-8 Gecko 41
SA-9 Gaskin 40
Sabre 94
Sagger (AT-3) 94-95
Salish 95
Samlet 95-96
SA-N-1 Goa 42-43
SA-N-2 Guideline 45
SA-N-3 Goblet 43
SA-N-4 96
Sandal (SS-4) 96-97
Savage (SS-13) 97
Sawfly (SS-N-6) 98
SA-X-10 98
Scaleboard (SS-12) 99
Scamp/Scapegoat (SS-14)
  99-100
Scarp (SS-9/FOBS) 100-101
Scrooge (SS-XZ) 101
Scud-B (SS-1c) 102
Scud-C 102
Seacat (Swedish Navy des-
  ignation RB07) 102-103
Sea Dart (CF.299) 103-104
Sea Killer Mk 2 104-105
Sea Skua (CL834) 105
Seaslug 106
Sea Sparrow (RIM-7H) 106-107
Seawolf 108
Sego (SS-11) 108-109
Sepal (SSC-1B) 109-110
Serb (SS-N-5) 109
Shaddock (SS-N-3) 109-110
Shahine 111
Shafrir 111
Shillelagh (MGM-51A) 112
Shrike (AGM-45A) 113
Sidewinder (AIM-9) 113-114
Siren (SS-N-9) 114
Skean (SS-5) 115
Sky Flash 115-116
SLAM 116
Snapper (AT-1) 117
Spada 117
Sparrow (AIM-7) 118-119
Spartan (XLIM-49A) 119
Sparviero 120
Sprint 120
SRAM (AGM-69A; WS-140A)
  120-121
SS-1c Scud-B 102
SS-4 Sandal 96-97
SS-5 Skean 115
SS-9 Scarp 100-101
SS.11 121-122
SS-11 Sego 108-109
SS.12 122-123
SS-12 Scaleboard 99
SS-13 Savage 97
SS-14 Scamp/Scapegoat
  99-100
SS-16 123
SS-17 123-124
SS-18 124
SS-19 124
SS-20 124-125
SS-21 125
SS-22 125
SSBS (S-2) 125-126
SSBS (S-3) 126-127
SSC-1B Sepal 109-110
SS-N-2 Styx 133
SS-N-3 Shaddock 109-110
SS-N-5 Serb 109
SS-N-6 Sawfly 98
SS-N-7 127
SS-N-8 128
SS-N-9 Siren 114
SS-N-11 128
SS-N-12 128
SS-N-13 128
SS-N-14 128
SS-N-15 129
SS-NX-17 129
SS-NX-18 129
SS-XZ Scrooge 101
SS-X-?s 125

Standard ARM (AGM-78 and RGM 66D) 129-130
Standard Missile (RIM-66/RIM-67A) 130-132
Stinger (XFIM-92A) 132
Styx (SS-N-2) 133
Subroc (UUM-44A) 134
Super 530 134-135
Super Falcon (AIM-4F/G) 136
Super Pluton 81-82
Swatter (AT-2) 136-137
Swingfire 137-138

Talos (RIM-8G-AAW and RIM-8H-ARM) 138-139
TAN-SAM 139
TAN-SSM (KAM-9) 56
Tartar (RIM-24) 139
Terne Mk 8 140
TGSM 140-141
Tigercat 142
Titan II (LGM-25C) 142-143
Tomahawk (AGM-109/BGM-109) 143-144
TOW (BGM-71A) 145-146
Trident 146-147
Type 64 ATM-1 (KAM-3D) 55

UGM-27 Polaris 82-83
UGM-73 Poseidon 83-84
US Roland 148
UUM-44A Subroc 134

V75OVK Guideline 45

Walleye 148-149
WS-140A SRAM 120-121

XFIM-92A Stinger 132
XLIM-49A Spartan 119
XMIM-104 Patriot 76-77

Ze'ev 68

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